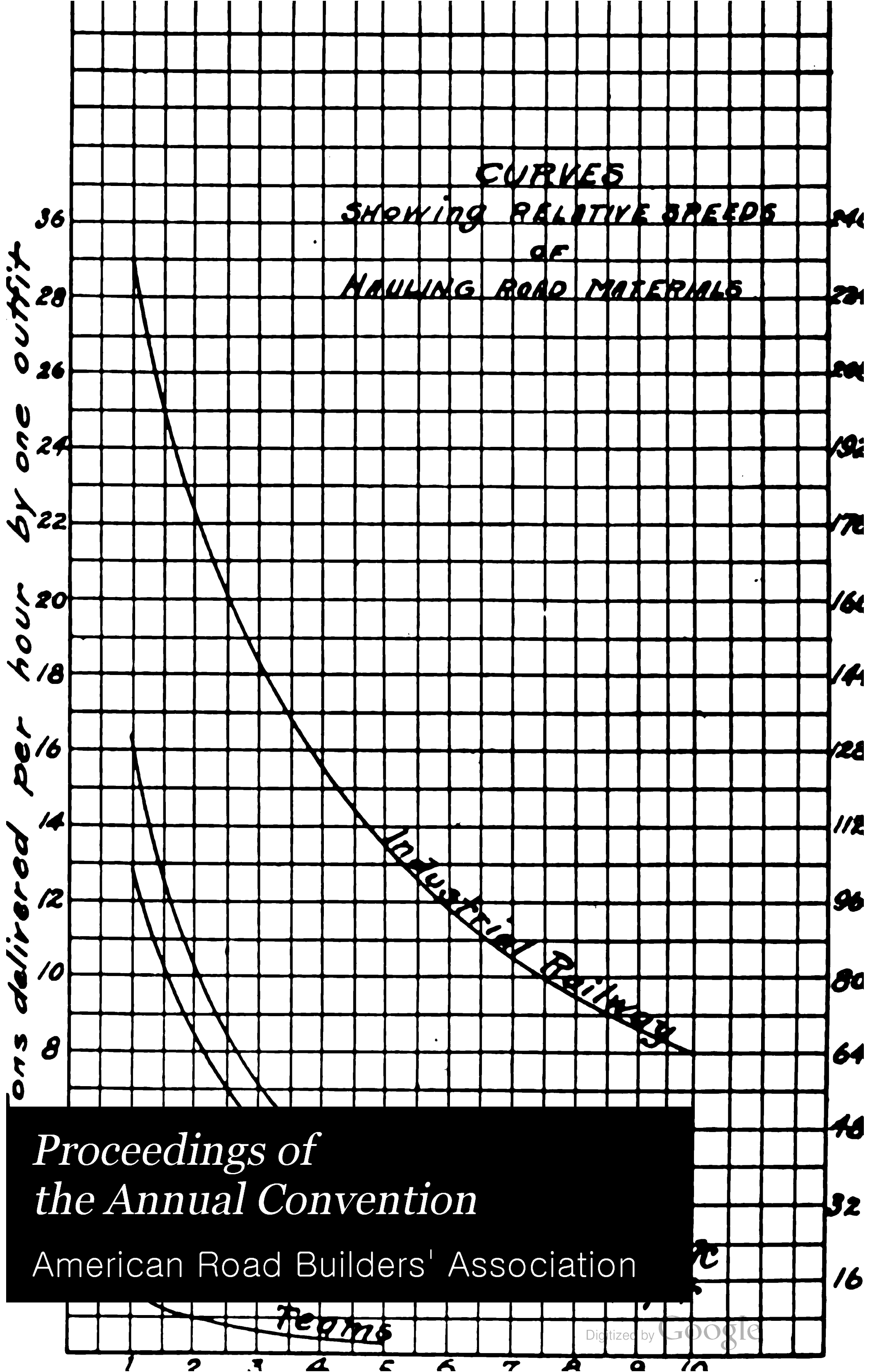

Proceedings of the Annual Convention

American Road Builders' Association

PROCEEDINGS

OF

THE EIGHTH ANNUAL CONVENTION

OF THE

American Road Builders' Associat

Held at Rochester, New York
November 14, 15, 16 and 17, 1911
together with
Reports of the Executive Committee, Secretary and Treasu
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The eighth annual convention of the American Road Builders' Association and the American Good Roads Congress, with an accompanying exhibition of road building and paving machinery and materials, were held at Rochester, N. Y., on the fourteenth, fifteenth, sixteenth and seventeenth of November, 1911.

The total registration was 1,461, the delegates present coming from all over the United States and from Canada. Among them were the chief road officials of the states of Washington, Maine and Alabama, as well as nearer states. Practically all the delegates were men actually engaged in road or street work and many of them were men who are known throughout the country as experts in their respective lines.

All of the nine sessions of the convention were held in Convention Hall, and were well attended. It is also worthy of note that the sessions were begun and adjourned punctually, and that the program was closely followed. Each of the five papers introducing a special topic was presented as scheduled, and the formal discussions of the topics were by the men who had been chosen, except in three cases, in one of which the speaker selected prepared a paper which was read.

Another noteworthy feature was the presence of an unusually large number of officials, engineers and contractors engaged in paving. Though previous conventions have been attended by those engaged in street work as well as road work, the percentage of the former was larger at this last convention than at others.

The exhibition of road building and paving equipment and materials was held in the annex of Convention Hall and on the plaza and street adjoining the building. It included various machines and tools, and a variety of materials.

Proceedings
of the
Eighth Annual Convention

FIRST SESSION
Tuesday Forenoon, November 14

The convention was opened with an invocation by the Reverend Dr. C. C. Albertson, Pastor of the Central Church.

PRESIDENT PARKER: I am sorry to have to commence our proceedings by announcing to you that Governor Dix is unable to be present today. But he will be represented by Mr. C. Gordon Reel, the new State Superintendent of Highways.

MR. REEL: Mr. President and Gentlemen of the American Road Builders' Association:—It was with keen regret that I learned on Saturday morning that it would be impossible for either Governor Dix or Lieutenant-Governor Conway to be with us today to extend to you a cordial and hearty welcome to this convention. Their absence is unavoidable on account of important public matters which demand their personal attention. I am, however, much gratified and honored to be delegated to perform so pleasant a duty as that of welcoming you to our Empire State.

Our system of state and county highways leaves much to be desired. In the first place, largely because of the provisions of our highway law, we have not built any sort of a comprehensive, continuous system of trunk lines, but on the contrary have built little disconnected roads here, there and everywhere throughout the state, without reference to through lines of travel. This condition will be materially remedied by this year's legislation and if certain amendments to the highway law can be effected next year, it will be possible for us to build a system of state roads which will really serve the people.

As regards the construction of the roads themselves, a woeful lack of judgment was shown in building one kind of road practically for all kinds of traffic conditions. The result is that many of our roads were built in such a way as not to be able to withstand the traffic they had to bear, and, conversely, altogether too expensive roads, which did not meet the local requirements, were built in rural dis-

tricts. Complaints come into our office daily about roads built for farmers' use which are so slippery that horses cannot keep their footing and the people have to either drive through the fields or scramble along the shoulders of the roads the best way they can. And strange as it may seem, a much cheaper kind of road would have been entirely satisfactory and serviceable. There is, therefore, an opportunity for the present commission to work a great benefit to the state by simply building roads of the right kind to meet local conditions, and there is a further opportunity to greatly reduce cost by using local materials, labor and machinery.

The burning question with us, as I suppose it is with all of you, is that of maintenance. We have been deceiving ourselves into the belief that we were maintaining roads when as a matter of fact we were not maintaining them at all. Any system of maintenance which allows a road to wear out and require complete rebuilding and resurfacing is not maintenance. Nothing can be more axiomatic than that if maintenance is to maintain, the structural strength of the road itself must not be impaired. You can get some idea of what our maintenance charges are when I tell you that our system of town roads cost six and one-half million dollars this year, sixteen hundred thousand of which the state paid, and that our system of state and county roads cost almost a million and a half for maintenance and repairs alone, twelve hundred thousand of which the state paid. The state has, therefore, spent almost three million dollars this year for maintenance of state, county and town roads and with the great extension of state and county roads, and considering their rapid deterioration as now built, the amount the state will have to contribute will reach ten million dollars a year upon the completion of the contemplated system.

If the present commission is to best serve the interests of the people in the state it must be empowered to build roads where they are needed and of a kind and at a cost which comport with the local requirements.

I again welcome you and sincerely hope that your deliberations will result in much progress and lasting benefit to this all-important cause, which is so near the heart of every citizen. (Applause.)

And in closing, I want to express, personally and for

our department, our appreciation of this very splendid exhibit that the manufacturers have provided here. It is a most creditable and valuable thing, and I want all of you gentlemen to realize that we deeply appreciate your labors.

PRESIDENT PARKER: I am about to introduce to you a person whom I suppose very few of you know, His Honor the Mayor of the City of Rochester, who will say a few words to us.

MAYOR EDGERTON: Mr. Chairman and Gentlemen:—It is a pleasure for me to be here this morning, and to extend to the road builders the greetings of my fellow citizens.

Your committee, or whoever had control of selecting the place to hold your convention, exhibited great and good judgment in coming to Rochester. We have here a beautiful city that we are very proud of, a city of homes, a prosperous and contented and happy people. We have a clean city, too, in every respect—splendidly improved; miles of good roads—and they are well cared for. Our city is clean physically and morally, and for fear no one else will say so, I will say that we have got a clean city government. (Applause.)

We are glad to have you here. We are somewhat selfish in inviting you here; we expect not only to give you a good time while you are here, but to absorb from you much information that will be of benefit to us. We want you to look about and see our public improvements—see our public works.

I am sorry the weather could not have been better and more agreeable for getting around out of doors. We not only have a beautiful city but we have a beautiful surrounding country. This is one of the garden spots of this country. Monroe county, outside of Rochester, has over nine hundred miles of improved roads, state, county and town. We have four hundred miles more which will be improved, if they give us a little more time. There will be a time when every road in Monroe county will be a good road.

I trust your deliberations will not only be pleasant and agreeable, but profitable, and that you will take away with you from Rochester, such good impressions that you will all want to return.

I thank you very much for your attention. (Applause.)

PRESIDENT PARKER: I am very sorry to say that Dr. Smith, the Chairman of the Board of Supervisors of Monroe county will be unable to be here. But the sheriff of Monroe county has consented to come, and I am about to introduce to you Mr. Willis K. Gillette, Sheriff of the County of Monroe.

MR. GILLETTE: Mr. Chairman and Gentlemen of the Good Roads Congress and the American Road Builders' Association:—On behalf of Monroe county it affords me great pleasure to extend to you a most hearty and cordial welcome. The mayor has just reminded me that he forgot to tender you the keys to the city—on his behalf I do that for you. I tender to you also the keys of Monroe County Jail. (Laughter and applause.)

The mayor has spoken of this beautiful garden spot and flower city of homes of ours, and has bade you welcome, but the county of Monroe in its vast domain, includes this beautiful city, and it has interests that are peculiarly in harmony with the purposes which bring you here. The great garden fruit belt along Lake Ontario, extends thirty miles to the east and some seventy miles to the west, and this beautiful valley of the Genesee with its rich bottom land is also here. So we are particularly glad to welcome you in view of our interest in this great movement; for Monroe county, gentlemen, is one of the pioneer counties in the movement for good road building, and the Hon. William W. Armstrong, of Rochester, our former senator from this district is the father and one of the authors of the Higbie-Armstrong law, the first bill that provided for state aid in the matter of road building. This county has so persistently and indefatigably availed itself of the provisions of that law and other laws in regard to state aid, that today we have over two hundred miles of improved roads in this county, built under state aid, at a cost to the state and the county and the townships of upwards of $1,375,000. And I commend to your attention, gentlemen, a pamphlet that has been prepared by our county superintendent, Mr. J. Y. McClintock, and District Supervisor Cribb of the Highway Department, which shows in a condensed form all that has been accomplished in the good roads movement in this county, and is in itself a liberal education in good roads matters.

This county of Monroe, gentlemen, we believe from

legend and tradition is the Garden of Eden, the place where Adam and Eve first saw the light of day. And then, when his Satanic Majesty tempted them and they were driven out of the Garden of Eden, after the Devil had witnessed his work, tradition has it that he took what is now called the Ridge road toward Niagara Falls, and as he reached the Niagara river he cast his eyes backward over his shoulder, and surveyed the blossoms and the trees and the shrubs, and saw what he had accomplished by casting out the original parents of our race, and he turned suddenly on his heel, causing the Whirlpool Rapids of Niagara, and fled to the rocky barrenness of Canada. (Laughter.)

In the early movement for good roads in this county, some of us were prone to feel that on the roads which were being built at an expense of $8,000 to $13,000 per mile too much of the cost was devoted to office expenses, engineering and surveying. These roads were built upon stereotyped plans, without sufficient attention being paid to quicksand and soft clay, so that the macadam would sink out of sight in a few months. But our recent highway commission and others in state authority have been making a study of this question of road building, which is in its infancy, too, by experiments, and we are having roads built here and throughout the state which will stand up much better. And in this county and city you will find that some attention has been paid to the holding of the top dressing upon the roads, making them comparatively free from dust. You will find roads treated with various forms of oil, and tar and tarvia and chlorides—I will have to refer to the pamphlet to tell you the form of the chloride used—calcium chloride, I see it is. Calcium chloride is a dust layer. Our roads have been constructed of limestone, trap rock, royal limestone, granite, brick, concrete and other materials, as well as asphalt.

As I say, this road improvement, although in its infancy, has undergone wise experimentation and much has been accomplished. And from what we learn from the gentleman now occupying the position of state highway commissioner, whom you have just heard, we feel that he is big and broad enough, and broad-gauged enough to benefit by this experimentation and experience of the past, and do the work required of his high office along broad-gauge lines in man-fashion, without fear or favor of opinion.

In ancient Rome, roads were built that endured for centuries—in fact they endure to this day. Why? In the days of Caesar there were thousands of thousands of war slaves, and labor was no object. They gathered massive stones which were bound to endure the traffic. We have not today thousands of war slaves, but we have thousands of slaves of crime now languishing in our state prisons, whom, it seems to me might well be employed in this great and beneficient work of road building. (Applause.)

And they would be in better shape to reenter society at the end of their respective terms of confinement if they did, once in their lives, a little honest toil for the benefit of their fellow men. I put this forth merely as a suggestion for consideration during your deliberations here.

Thinking of this good roads movement, I naturally call to mind Mr. Isaac Budlong, the chairman of our good roads committee. Isaac, in conjunction with his saintly father —they are farmers—farmed one thousand acres of hay land about thirteen miles south of here, near Scottsville, in the fertile town of Wheatland. In those days I think they could carry only 1,500 to 2,000 pounds burden on the wagon, and Isaac was going along the highway with his 2,000 pounds of produce, pulling along on that slimy, filthy road, when he overtook two ancient dames who were displaying their thin ankles. They were trying to pick the high spots and the stones on the roadway, and Isaac invited them to ride on his wagon. They got up on his high spring seat and had progressed only a short distance when the horses disappeared in a mudhole, the spring seat rebounded, and the ancient dames landed head first in the muddy road. Isaac was as gallant as could be and he assisted them to their feet, and washed the dirt from them as best he could. But for many years those ladies refused to speak to Isaac. Now, Isaac goes down the road blithely with his two tons of hay on one wagon, $25 per ton, and those maiden ladies have commenced to speak to him again.

In the days that I speak of, some of our impecunious citizens complained of the cost of the roads; but now they are educated to the movement, and in spite of the cost, we are now ready and willing to have more and better roads, and we are willing to pay the cost.

I feel that my trespass has already been too long. I was pressed suddenly into service, and speaking extemporaneously, I cannot condense as I should. But in conclusion, permit me to say that if any of you get into trouble during your brief stay in Rochester, my number is "Main, 520" and "Home, 520"; and I grant you, by virtue of my office in this county, immunity from arrest. And I trust the hospitality you extend to our highway commissioner Mr. C. Gordon Reel, while he is with you, will not be so insistent and heavy upon him, that when he departs you will stand around and say "See Gordon reel!" (Laughter.)

I bid you Godspeed in your work.

PRESIDENT PARKER: Gentlemen, it appears to me that if all our sheriffs were as excellent in the administration of their offices as the sheriff of Monroe county, who has just retired, is excellent in his speech, we should have a most admirable administration.

The next address will be on behalf of the Rochester Chamber of Commerce by Mr. Albert B. Eastwood, President of the Chamber of Commerce. (Applause.)

MR. EASTWOOD: Mr. President and Gentlemen of the American Road Builders' Association:—I am here with a great deal of pleasure, and I appreciate the honor and the privilege, or behalf of some eight hundred business men who are working under the name of the Rochester Chamber of Commerce, of bidding you welcome.

The Chamber of Commerce has a very lively interest in the proposition that you are lending your energies to promote. Good roads is and has been a subject of interest in our Chamber of Commerce. Commerce has led civilization away from water fronts as the first means of transportation, and has been able to do so only over roads, good or bad.

I will detain you but long enough to suggest this thought: that we are particularly interested in getting at first hand, information that will give the public, which is most interested in good roads, a working knowledge of the fundamentals of good road construction. I assume that you have such literature as is of educational value to the man who wants to know. I want to assure you that the Rochester Chamber of Commerce is very anxious and eager to get such data as are easily understandable by the average man. I have gone through the state twice this

summer, and I was very much disappointed in some of the road construction I saw going on. I was much disappointed in going over roads that were completed within twelve months, only to find they were in very poor condition.

I submit to you the desirability of giving to the Chamber of Commerce and others, as much information as you deem desirable to the lay mind, on the practical principles of good road building, so that the farmer, seeing a road built in front of his place, will know whether or not it is a good road. Each man, when he knows a good road, is a booster for good roads.

Rochester today, through its retail stores, is delivering merchandise throughout the surrounding country within a radius of eleven miles, and to Fairport, even further than eleven miles. That is only possible because of good roads. We want the cooperation of every man that has a good road passing his place, and want him to be interested in good roads.

It has been a pleasure to see you, and I hope your stay in Rochester will be so pleasant and profitable that you will come again to our city. (Applause.)

PRESIDENT PARKER: Gentlemen, on behalf of the American Road Builders' Association, it becomes my duty to say a word to the gentlemen who welcome us to this beautiful town.

There are several people who follow me, whose records are so excellent that I am only going to take a few minutes, as I know you are anxious to hear these other gentlemen. Everybody I know is anxious to know what Sam Hill has to say, as he always has something interesting in view. In the absence of Mr. Hooper, the President of the American Automobile Association, Mr. J. Arthur Ritchie, the Secretary of the New York State Automobile Association, will speak.

Now, all I have to say to you gentlemen is that we, the members of this Association, most thankfully receive the words of welcome that the president of the Chamber of Commerce, and the mayor and others have spoken to us. We took into account every city, county and town in the United States when we considered where we should go with this conference. We compared one with another and we determined that Rochester, of them all, was the place to go

on this particular occasion; that it has not only the most satisfactory arrangements for conventions and exhibits of all sorts, but its people have an abounding welcome for all who are going to help them, and their hospitality is appreciated, I assure you. That is all I will say in reference to this particular matter.

It devolves upon me to appoint certain committees which are to act during the congress: One is the committee on resolutions and the other is the committee on credentials. I have been assisted by the most able minds here in preparing this list.

On resolutions I appoint the following committee: Nelson P. Lewis, Clifford Richardson and Charles W. Ross. If any gentleman declines or wants to decline to serve, he must say it now or forever hold his peace.

As a committee on credentials I appoint the following: Samuel Hill, G. W. Cooley, Paul D. Sargent, E. L. Powers, R. A. Meeker, P. St. J. Wilson, J. Y. McClintock, M. Driscoll, C. P. Price and W. H. Connell.

In the order of addresses which follow, and in order to get in all the work we have before us, I am going now to ask Mr. Samuel Hill, President of the Washington State Good Roads Association, to say as many words to you as he will. Mr. Hill, Gentlemen. (Applause.)

MR. HILL: Gentlemen, it is a great pleasure to look into your faces again. As I look around I see my friend from Alabama and another from New York, and I see Mr. Clifford Richardson here on the platform and Mr. Harold Parker also, and many whose faces have been familiar sights at every convention on good roads, which I have attended; and on my right hand I see my friend, Mr. Cooley, the commissioner from Minnesota, with whom, thirty years ago, I carried an ax while he carried a transit to lay out a road in Minnesota. We miss, however, one face from this gathering—I refer to Mr. James H. MacDonald, of Connecticut, whom many of you know.

I have been, in the last thirty nights, twenty-two nights on a sleeping car. I got here last night and got to bed at two o'clock this morning, and I am not prepared to say to you the words I would like to say.

I regard this convention as one of the most important, if not the most important, convention ever held. But, first, I want to say a word, Mr. Mayor and Mr. Sheriff,

about your kind reception here. I was very much gratified indeed when Mr. Parker told me that I was to follow the sheriff and not have the sheriff follow me. I was glad when I heard this Garden of Eden described, and particularly when the mayor spoke of the climate here, and I recalled the words in scripture, that when Adam and Eve had just left the Garden, Eve remarked to Adam, "What a remarkably early fall we have had." This is indeed a garden spot in a garden land.

The man who has control of transportation has always dictated the policy of the world. There was a certain man named Mr. Noah, and he was a monopolist. In his day they had no roads, but did have water transportation, and on one occasion when he went out, he not only declined freight, but refused to carry passengers, and the Ark sailed with only those that he wanted to take on board.

This matter of primary transportation is easily and far away the most important question before the American people today. There are men here in this room who will speak to you and who will tell you in every detail about how to build and place the best roads. They will say, perhaps, as a distinguished candidate for the presidency said, that the tariff is a local issue; and so road building is a local issue.

Some of you heard me speak a year ago about the question of convict labor. We in the far West believe that that settles two questions, and I will repeat, if I may, a short account of what happened on a road we are building by convict labor along the great Columbia river.

A big, thick-necked contractor came along and he said: "You cannot build a road that way, Sam Hill or any other man. I am a contractor and I know." I said, "You are a contractor and you don't know. I will take you down there as my guest and show you." We got to the place and after going around and seeing the work, he said, "Mr. Hill, this is a very remarkable camp, I do not think I have seen any better than it at any time." "Do you think so? It is the best I have ever seen and I have seen thousands of them," I replied. "Not thousands of them, Mr. Hill!" I said, "Yes, as President of the Washington State Good Roads Association, I have seen thousands of them." He said, "Well, I did not know that." "No, you did not know it, but you talked," I replied.

This camp was clean and dry and the men were very well housed, and when they came in from their work, they had free tobacco and plenty of good, nourishing food.

Then we went over to another part, and he looked at the rock and he said "This is the most remarkable rock I have ever seen. What do you pay a man to get that out for you?" I said, "I give him his board and his clothes." He said, "His board and his clothes?" I said, "Yes, he is a convict." He said, "Ain't you afraid of him?" I said, "No." Then he said, "How much powder does he use?" And I told him. Then he said, "He cannot get out that amount of rock with that amount of powder." I said, "This man is a specialist, a safe-blower, and he does not waste any powder. He puts in a few grains and makes it do all that it can do. He makes no false moves."

He said: "Who is that man in the cap?" I said, "He is a sergeant. Major Ball was a West Pointer, and he had army sergeants buy their time and when he got a man that he knew knew his business and did a day's work, he would have that man buy his time, and they serve here." I said, "You understand, that man is a dead shot. He would shoot the eye out of a bird on the other side of the road. And the convicts hear me tell him that if he shoots and wings a man he will lose his job, but if he kills him outright it is all right. No one tries to escape after that."

Then he said: "This is remarkable cooking you have here, Mr. Hill. Who does your cooking for you?" I said, "He is an expert cook. He used to run a German restaurant; he is in for trying to kill the second cook."

He said, "What noise is that I hear?" I said, "I do not hear any noise." "Don't you hear that? Go out and see." I then said, "Oh, that is a kennel of bloodhounds in case the sergeant misses them."

He said, "These men work like fiends for you. Do you drive them?" I said, "No, we have an indeterminate sentence here in this state, and they get out much quicker by doing what is right and proper." Nineteen were freed a short time ago, I told him. That is the settled policy of the state I come from.

The governor of Oregon invited me some time ago to come over and see him and I went over there about thirty days ago, and explained this matter to him and at the last election the counties voted by a two to one vote to go ahead with this plan.

Colorado and other western states are doing this. When your highway commissioner spoke, he said it was a question of raising the money. Now, here is an asset which the state has, or rather, which can be turned into an asset, but is now a dead loss. But convict labor does more than build roads; while you are making roads with the convicts, you are making men of them. That is a much better work, as there is no work in the world like humanitarian work. When those men come to us they are many of them pickpockets and burglars and thieves, and when they leave us they are strong and self-reliant and they know their strength, as knowledge is power. I won't speak more on that just now.

Here in Monroe county, you are, indeed, very fortunate. You have almost everything that one may desire, but you must remember that you are part and parcel of the whole United States; that we must stand or fall together, and that you must reach out your helping hand to those of us who live on the outskirts of the country.

Mr. Harold Parker, our distinguished president, has for years led the way in Massachusetts, and that state, small as she is, has done a vast deal of work in this line. Massachusetts sent Mr. Harold Parker across the country to all the conventions, that its highway department might get all your ideas on good roads, and try them out and then give you its ideas of good roads. And so, having all these things here before you, you must try to take the time to educate further some of us who live in the outskirts.

I was on a train not long ago with a very distinguished citizen now passed to the beyond, Mr. Denman Thompson. Thompson was a little near-sighted and he tried to force his way down the aisle past some people who were in the way, and he did not see for an instant that the man who blocked the way was handcuffed to a detective. He said, "Hurry up here. Time is money. Move on." The man turned and said "If you think time is money, I have five years I do not want and haven't any use for."

I only wanted, in saying the trivial things to you, to make a smile come over your faces, and assure you that here is where my heart is. I regard you as the most interesting public servants of all that I know. Your work is not recognized at present as it should be, but some time, perhaps not in your lifetime, the reward will come to you all.

I thank you for this opportunity to make a few remarks, and I hope some time during the convention, to discuss some of the measures that come up. I thank you. (Applause).

PRESIDENT PARKER: Mr. Hill generally gives us a longer talk, but he has been traveling for twenty-nine days without sufficient rest or sleep, and that is the reason he is not quite up to his standard in the matter of time, although what he said is excellent, as usual.

Mr. Bachelder, Master of the National Grange and ex-governor of New Hampshire, has been detained in some way. He is not here, but Mr. Powers has persuaded Mr. Frank Terrace of Seattle, Washington, the same state Mr. Hill comes from, to talk to you on the same subject which Mr. Bachelder would have talked about.

I think you will enjoy Mr. Terrace's talk, as I have heard him frequently and I consider him a "star." (Applause).

MR. TERRACE: Mr. Chairman and Gentlemen of the Convention:—I did not expect that I would be called upon at this particular time. This is unexpected by me and as I am only a plain, country farmer, and not used to making talks in public, you must not expect much from me.

I am a granger and I have to take the place of the national master of the grange, that great and wonderful institution composed of farmers all over this broad land of ours, from the Atlantic to the Pacific—men that are tilling the soil, the men who should be most interested in this good roads movement of any class of people in this great country of ours. I am sorry to say that even among them they are divided on this great road question that is before us today.

As you know, a road is like a good restaurant in a city—it does its own advertising. (Applause.) If a man gets a good meal in a restaurant you can depend upon it that he will come back and bring his neighbor along with him. This good roads movement is identically the same, but the great trouble with the rank and file of the farmers of this land is that they know nothing about good roads. They have not seen them. When you go out into the great western states, where they have no roads and know nothing about roads, it is no use talking to them. You must educate them by degrees, and finally show them the road and then they believe in it; and they will work hard in the interest of it.

I well remember when I was converted to this great

good roads movement. I took a trip to the old country—over to England. I went through this beautiful country of ours and reached Chicago, and saw the beautiful buildings and the great bridges. At New York I saw the same thing. And I saw the same in the matter of bridges, and their beautiful buildings on the other side, and then I said to myself, "Our country could come up to them in any kind of structure such as a house or a building." But when I went out on their beautiful highways, stretching over hills and valleys, with beautifully trimmed hedges and macadam sidewalks for people to walk on, where everybody enjoys the benefit of the public highways, I hung my head in shame. I thought, "Isn't my country big and bold enough to have as good roads as any nation in the world?" I then came to the conclusion that when I reached home again, I would use my best endeavors to improve our highways. I talked highways in the morning and at night, and it was highways first, last and all the time. And I made very little progress in my own humble way.

I will tell you a tale which you must remember, for whenever Brother Hill finds out that you are interested in this good road movement, you may as well be in Purgatory until you get on your harness and work in the movement. There was an old lady who was hard up and who was on the point of starving, and there were two or three hoodlums that knew of this. She was very poor and one of them said to the other, "Wouldn't it be a good joke to buy a five-cent loaf of bread and throw it in to her." They bought the loaf and they went to the old lady's cottage, as she was sitting with her back to the door, without a bite to break her fast, and threw it in the door. The old lady jumped up and picked up the loaf and said, "I thank Thee, O Lord, for sending me that loaf." One of the hoodlums put his head in the door and said, "Betty, do you mean to say the Lord sent you that loaf?" She replied, "Yes, the Lord sent the loaf, even if the Devil fetched it." (Laughter).

Now, bear that point in mind.

I was talking roads in our country, and one day Mr. Hill dropped into the city of Seattle, and there was an item in the paper that Mr. Hill would talk on improved highways. I went down to hear him and I heard what he had to say, and I went back to my little town and I told my neighbors about it. They said: "What is he? He is a railroad man.

What interest has he in good roads? It is to his interest to be against good roads." I said: "It does not make any difference what interest he has in them if we get the good roads." And so I say about the good roads: It doesn't make any difference if the Devil brings them; it is all right. (Laughter.)

We got our county commissioners persuaded to let us have one and a half miles of good road. The county commissioners were to furnish the means, and the government of the United States was to furnish the man to supervise the work, as they considered there was not a man in the state of Washington who was capable of supervising that work. We started in and the road was built in a valley where I live, where there are great freshets during which we have six and seven and eight feet of water sometimes from side to side of that valley, and steamboats can run all over the valley. This mile and a half of road was to be constructed along the banks of the river in that hollow. The young man sent from Washington started in and the old-timers shook their heads, and the road supervisors who had been filling up these mudholes for thirty years shook their heads. They had been merely filling up the mudholes for thirty years, and when it rained the filling would all wash out.

The road was finally built and the flood came that fall. We have a great range of mountains running north to south through that state, peaks 14,400 feet high, and with immense snow falls on top of them, and in the spring the water comes down when the snow melts off of those mountains and steppes, and all of the lowlands are flooded over, although they are the richest lands on the face of God's earth when the floods have subsided. That fall we had a flood that was heavier than usual, and we had eight feet of water over that road. I spent many anxious days and nights while that road was under water, for I knew that if that road went out and Mr. Hill came out there, they would hang him. And I do not know what they would have done to me; I would have had to leave the country. But, Mr. Chairman, when the flood went away, the road was there, not a bit the worse for being under water nine days.

We have been having more and more roads, until today the state of Washington has two hundred miles of macadamized roads and several hundred miles in course of construction.

What has it done for our farmers?

I remember that before the road was constructed in that valley, where I lived, one year I raised seventy-five tons of cabbage. I am a dairyman, and I have a great truck farm besides. I had to haul that seventy-five tons of cabbage to Seattle, which is fourteen miles from my home. I had large horses—if there are any farmers among you, you will realize the size of the horses, when I tell you that they ran from 1,600 to 1,800 pounds in weight—and 2,500 pounds was the best load I could haul with them. I left home at six o'clock in the morning and got back at six o'clock at night, a tired man with a tired team, tired from pulling through mudholes all day long. Allowing myself $5.00—which was little enough—to land that 2,500 pounds of cabbage into that great factory, you can see what the conditions were. Now I put my three tons on, and I leave at seven o'clock in the morning and I get back at five, without a turn of the hair on my team, and it is a pleasure to travel over the road.

What does that mean to me? It means, that if it took $5.00 to take 2,500 pounds of cabbage to market, that I now haul three tons for the same amount. So, gentlemen, is there any investment on my farm which pays me such a return as that road does? It pays me greater returns than anything else. I had better do with one-half the land and have that macadam road. It would take $300 to haul that cabbage to market under the old system, and I hauled it in for $150 on a macadam road. That was a saving of $150 on that one item alone to me, as a farmer.

More than that, I am a dairyman, too. We have to haul our milk from the farms to the railroad, with hauls ranging from one mile to three miles to get our milk into Seattle. We have to hitch the team up to get that milk over to the station, and we pay one cent a gallon for taking that milk in. If a man had 100 gallons to ship to Seattle, it cost one dollar for taking the milk in and bringing the empties back. Now, what have they done since that road was started? They have put on those large automobile trucks, and they come and take your milk at the farm, they fetch your can back, and charge you half a cent a gallon. You were paying one cent to the railroad, after hauling it to them, and now with the automobile trucks, you pay one-half cent, and that is fifty cents a day that a man saves on

that item. That means $15 a month on his milk, and besides he has not got to hitch up his team in the morning and take his milk to the station, and fetch his cans back. Moreover, that automobile truck delivers the milk right in the city to the retailer, and that man has not got to go to the railroad for his milk.

Now, those items pay the farmer for the cost of the road in one year—in one year—I care not what the cost of the road is. It seems to me that men should not stand in their own light so long.

I claim that good roads is one of the greatest issues before the American people today. There is nothing like it. The tariff is a mere bagatelle in comparison.

How long shall we keep on in these old ruts, filling in mudholes year in and year out?

I am sorry to say to you men who are trying to build and construct the roads, that the very people you are trying to reach are your worst enemies—those whom you would help and benefit most. But the work takes a head and it takes agitation. This great movement will not be completed in a day, nor probably in my lifetime, but it is coming as sure as the sun is rising and setting. Nothing can stop this movement. Once the people get a taste of it and a trial of these good roads, they will not go back to the old rut and the old system.

As I listened to the sheriff of your county, as he touched upon the great question of convict labor, his words took me back to my own state. As you know there must be a head; there must be a guiding hand. Bonaparte was a great soldier, but he was more than that—he was a great road builder, one of the greatest road builders of the world. If you go through France, you will find monuments of road building that stand to his credit. We tried the convict labor in our state, and the question was put to the Board of Control to see if convict labor could be employed on our highways, and they had to report at the next coming convention. They reported that it could not be done; that it was impossible to work convicts on the public highways, as it would cost too much to guard them and to victual and transport them.

Mr. Samuel Hill was president of the association. He vacated the chair and called me to it. He made a motion, and this is what he said: "I move you, Sir, that we do not

accept that report. I know that it can be done, and by the Eternal, it will be done"; and the motion was put and it was carried with a whoop, and the result was that Mr. Hill got the governor of the state of Washington to allow him fifty men, to be taken out of the penitentiary and placed on the public highway, as an experiment.

There was a certain piece of road on the Columbia river which was in a mountainous country, and mostly in rock, and it was a hard country to build in. The best bid they could get from free labor was $9,500 a mile. These fifty convicts were taken out of the penitentiary and to this piece of road. Mr. Hill visited them on that road, and said, "Men, the eyes of the whole country are on you. I want you to do good work. I will see that you are well fed, have plenty of tobacco, and that every month you put in on this road will count for you." They promised that they would do the best they could, and the road was completed at a cost of $4,600 a mile instead of $9,500. The price was cut nearly in two, after having to take the men back and forth and feed them. That showed plainly the way the wind was blowing.

We will work convicts in the state of Washington in the mountains, which is hard work for them. I visited the convict camp, because they were so sensitive in my grange that they wanted to know if the convicts were treated as they should be treated, and sent me to visit the camp for the purpose of finding out. I went among them and I saw what food they had. It was just as good food as any man wants to eat—as good as any laborer gets in any part of this country. I asked them if they were satisfied or if they would prefer to be back in the penitentiary. They said they did not want to go back to the penitentiary. They were in the pure mountain air, and they saw the boats in the Columbia river, which afforded them some little entertainment, and moreover, they learned how to work. That was the trouble with most of them; they did not know how to work before. So now we are making them useful to us as well as useful to themselves.

I did not intend to say much when I came here, but having gotten up I thought I would make these statements to you.

I thank you very much for your attention. (Applause.)

PRESIDENT PARKER: We have had a chance to see

what Washington has within its far distant boundaries. You would not think to look at Mr. Terrace, that he was such an orator as he has proved himself to be; but I knew it, as I had heard him on other occasions.

Mr. R. P. Hooper, President of the American Automobile Association has not been able to get here, so I will ask Mr. J. Arthur Ritchie, Secretary of the New York State Automobile Association to say something.

MR. RITCHIE: Mr. President and Gentlemen:—I regret that President Hooper of the American Automobile Association and President Webb of our association are unable to be here to speak to this convention.

The New York State Automobile Association which I am connected with, is a representative association of automobilists in the state of New York. This year there are approximately 80,000 automobiles, one for every mile of highways. This vast army of road users is naturally tremendously interested in good roads. Our association is actively cooperating with the New York State Highway Commission, with the county superintendents of highways, and so on down through the organization, in every way that it knows how, for the furtherance of the construction and maintenance of good roads. We are not only lending our moral support, but we are actively cooperating in things that are worth while. One of the greatest objects for which we are working at present is the bonding of the state for an additional fifty million dollars, to complete the present system of highways. With the legislative machinery working as smoothly as possible, it will take until the spring of 1914 before that fifty million dollars can become available, and we are bending every effort and cooperating with the New York State Grange and others to put that extra fifty million dollar bond issue through.

We are also tremendously interested in federal aid in road building, and through the efforts of our national organization, Speaker Champ Clark of the National House of Representatives has put himself on record as favoring federal aid in the construction of interstate highways. We are also interested in getting better detours, and in the better maintenance of roads throughout the state and in the universal use of the road hone on our earth roads.

I would like to point out to you what we have done in the past in active cooperation. We have tried to stimu-

late interest among our fifty clubs and to get together with the county superintendents of highways and the good roads committees of every town in their territory. With this in view, our clubs have offered prizes in varying amounts in their districts for the ones who put up the best sections of road during a season. Some of our clubs are buying road hones and paying farmers on certain roads to drag with those hones after rains. Others are going into the unincorporated villages, villages that are too poor to do this work, and helping them out, so that they can build connecting links with other roads. So I might continue to show how we want the cooperation of the highway officials in the state of New York as well as those throughout the country.

I want to pledge you, in closing, the hearty and unanimous support of the New York State Automobile Association, and through it, the American Automobile Association, in the work you are doing.

Gentlemen, I thank you. (Applause.)

PRESIDENT PARKER: That concludes the exercises of the morning. The second session will begin at two o'clock this afternoon.

The meeting is therefore now closed, to be again resumed at two o'clock this afternoon.

SECOND SESSION

Tuesday Afternoon, November 14

PRESIDENT PARKER: Gentlemen, you will please come to order.

This afternoon's session will be an exceedingly interesting one. Mr. Bensel, whom all of you know, either by personal acquaintance or by reputation, is going to deliver the first speech of the afternoon, and those things which he gives utterance to are to be argued and discussed by two distinguished gentlemen; and then we will have general discussion from the floor. It is not necessary for me to introduce Mr. Bensel to you. He is sometimes called the "King of New York," but his characteristics which have marked him among you for many years, his person-

ality, his wisdom and his knowledge, are recognized all over the country, and I shall leave Mr. Bensel to further proclaim himself to you by his own work. Mr. John A. Bensel, State Engineer and Surveyor of New York. (Applause.)

MR. BENSEL: Mr. Chairman and Gentlemen of the American Good Roads Congress and the American Road Builders' Association:—I am a little taken aback by the exceedingly kind introduction of your chairman, particularly after I had been compelled to refer to him as having just changed his occupation, and that possibly he had become less of an artist, which he looks, and more of a contractor, which he hopes to be. It is a little difficult to determine from a present inspection of your chairman as to whether he belongs to the artistic class, or whether that is simply something which he flies in the face of the public in order to make an honest dollar in that portion of the profession which he has taken up now, namely, contracting.

HIGHWAY ADMINISTRATION

By JOHN A. BENSEL

State Engineer and Surveyor of New York

I have been asked to speak on the subject of "Highway Administration" and while it may be possible that the one who assigned me this subject had a definite idea as to its meaning, I contend that to me it is a subject of varied interpretation and that I do not intend to hold myself within any narrow lines in this appearance before you.

One of the most impressive things about those that have to do with highways is the remarkable spirit of complacency that has been developed among all those who are recognized as masters of the art of highway construction, and it seems to me that this spirit must extend also to the administration under which they work and it would, therefore, be impolitic on my part to endeavor to offer any distinctions between the right kind of administration, as may possibly be exemplified in my state, and those that differ from it in adjoining states.

The commission in this state is still so new to the business that it has a critical attitude toward everything connected with highway work from administration to construction. In fact, the whole proposition of good road construction

is such in its variations that one is reminded of the complaint of the poet of olden times when he said:

> "There are nine and sixty ways
> Of constructing tribal lays
> And every single one of them is right."

As an instance, I might mention that probably the most insisted upon requirement of proper organization which you will hear of will be the necessity of taking the matter of highways, in its entirety, out of politics. This demand is more general among those appointed by the party that has secured the least number of votes in the last general election, but I wonder what would be left to be voted upon if all of the matters that are considered from time to time by important people as being properly outside of politics were removed therefrom. Certainly our elections would be innocuous enough and sufficiently barren of interest as to put aside from any possibility of desire the question which is now uppermost in many states of whether or not women should vote. In fact, it would seem as if matters might be so arranged that no women would desire to vote and probably only a few men. Directly contrary to this, however, there may be noted at the present time a tendency to try the referendum on almost all questions, and it appears to me that there is no reason why highway organization is not as good an object to try it on as any other. And this brings me to the first point of my argument, and that is, that I believe that the heads of state highway organizations should be elective officials, as they are in this state. Of course, those who have to do with the technical part of the work are supposedly immune from all questions of politics and do not, therefore, come under any necessity for special designation, and, in the main, being civil service employes, are thereby not subject to the changes that occur.

It cannot, I think, be claimed that there is as yet a sufficient amount of data to place road building in a definite class of engineering. Some engineering work has to be done in connection with the work but the lack of definite data to reduce it to a science can be understood from an inspection of the work in the various states where a large variation could probably not be made even if it were desired to vary for variation's sake.

Along with some other officials of this state, I was much impressed a short time since, on a visit of inspection in a neighboring state, by the remark of a well known official and road builder that he shuddered to think of the condition we would find ourselves in when the forty-one men in whom were vested the knowledge of good road building passed away. I think he was serious too, which perhaps might indicate that he was as much of a Scotchman as his name would indicate.

The basic principle involved in highway administration would seem properly one of economics, but it does not appear as yet that this aspect of the case has received anything but the most casual consideration.

Legislators have directed just where the improved roads were to be built and we have a fine example of administration in this state where you may note that the worst roads are, as yet, the connecting lines between the principal cities. To illustrate, take for instance the direct road between Albany and New York and between Albany and Utica, and the natural question that arises in anyone's mind traveling over sections of good roads seems to be as to what particular statesman lived at either terminal of the road on which they are traveling. Now, this is the kind of administration that, for the benefit of the people as a whole, should not be allowed. There is often a certain increase in a man's egotism which is particularly apparent when he is appointed for any number of years and this obnoxious trait in an officeholder is not nearly as prominently developed if his work is passed on at short intervals by a vote of the people. In fact, it may be said without any possibility of doubt, that there is nothing so conducive to humility in public life as to hold an elective office.

After all is said on this subject you will come back to the point that all good government administration must start from, and that is the personality of the administrator. Certainly good roads have the right to demand the capacity for administration that is found in the people who are successful in any kind of organization or administrative work. I am not an advocate of the principle that the positions filled by those directing the policy of highway construction should, of necessity, be filled by engineers, but it is likely that among at least some few members of this profession,

you will have the best chance of finding men capable of administering the involved matters that come up in the building of state highways.

Proper administration of highway matters may, therefore, be reduced to the proposition of selecting administrators of known capacity to carry on this work which is of such importance to the whole community, and in the carrying out of the work to leave them with as free and unhampered control as is possible under the laws of the state in which they are working.

The sums of money which are now being expended in this country for the construction of highways are of considerable magnitude, aggregating, I am informed, for the year 1911, as well as can be learned now from the United States government, about one hundred and fifty millions of dollars. Out of this amount, probably forty to sixty millions will be raised by a direct bond issue, without, in many cases, any noticeable plan for the redemption of these bonds when they become due. Further than this, the experience in this state shows that from ten to fifteen per cent. of the amount expended on the roads needs to be expended annually to maintain the roads as they have been built up to the present time.

It may readily be seen, therefore, that it will not be necessary to go far before it may become apparent that any state may be made bankrupt by carrying out all the desires for new and improved highways in sparsely settled communities. Careful study should, therefore, be made of each section of the state and the road construction adapted to the needs of the inhabitants, with such changes as may be necessary in order that through routes may also be provided along the lines of maximum travel between the main centers of population. And after this is done, it still remains to have some proper administration of highway officials to devise a road which in its maintenance will not take all of the good from the people which the construction of the road in the first instance seemed to imply.

I am glad to have appeared before you and to say that this particular platform was the scene of my greatest trouble when I went from the cool and calculating position of an engineer, and accepted a position where my work and my figures and everything which I do are put up to the

referendum of the people. While, of course, we many times feel that they should be taught the lesson they do not seem to know, still it is somewhat of a consolation to learn that my humility and my general disposition have been developed and improved, and my regard for the people of the state increased. And I am glad to be with you this afternoon. (Applause.)

PRESIDENT PARKER: I am sorry Mr. Bensel did not take up more time. I think he could entertain an audience for an indefinite time and keep its attention fixed upon him. I think it would be as great a compliment to secure Mr. Bensel to address you, as it would be to have Governor Dix; and I appreciate his coming and presenting to you the humility for which he is famous. Everyone living in New York knows what his humility is, and can appreciate his expression.

Now, to carry on this discussion, Mr. MacDonald, the former president of the association, was the first on the list for discussion, but owing to causes for which I am not responsible, he is not present. So I shall ask Mr. Cooley to step one notch ahead, and we will proceed without Mr. MacDonald. Gentlemen, I introduce Mr. Geo. W. Cooley, State Engineer of Minnesota.

MR. COOLEY: Mr. Chairman, Ladies and Gentlemen:—I am sorry to see there are only two ladies present—I was in hopes there would be more. But it will not do to ignore those two, for every time I try to make an address before a good roads congress, Mr. Hill or Mr. Powers, or some other good roads crank calls me down if I neglect to include the ladies.

When the good roads movement started in the state of Minnesota, which is my home state, it was with great difficulty that we secured an audience of over six men. Sometimes we would get eight and ten, and one time we got thirteen. At a convention held in the central portion of our state last Friday evening, composed exclusively of farmers, we had an audience of five hundred, and one hundred of that audience were women. That shows what a great interest the women take in this good roads movement—more perhaps in proportion to the numbers than we do. But perhaps not. But I have noticed that

wherever the women take an interest in any public question, something is bound to move.

Now, this good roads question is one which interests you and me and everyone. It interests the business man and the farmer and the casual traveler over our roads. It makes a difference to us individually, as whatever we eat or drink must pass at some time over the public highways. And we are paying the taxes for that transportation. I figured it out that it costs the city of Minneapolis and the City of St. Paul—those two friendly cities—about $250,000, every year to pay the additional freight on the material hauled into them, over what they would have to pay if they had a good system of transportation. It is costing us from thirty to thirty-five cents per ton per mile to transport our material, and in European countries you know it costs from eight to ten and sometimes fifteen cents per mile. In Minnesota we have hauled on a road lately at a cost of six and one-half cents per ton per mile, and if we had that entire system throughout our state we would have no trouble with our roads.

The question of administration of the public highway system is a matter of the utmost importance. When Appius Claudius built the Appian Way, he was the whole thing—the administration was entirely in his hands, and the result may be seen today, two thousand years after that road was completed. And it is in as good or better condition than when it was built. But road administration must be taken out of politics. I cannot imagine any system requiring such careful investigation and such careful study, being a success if interfered with by political influence.

I can best illustrate that by referring to my state, Minnesota. The administration of the highways is in the hands of three men chosen by the governor from different parts of the state, for their general business knowledge and not their road building knowledge. That commission was organized about six years ago. Every year one goes out and there is another appointed in his place. The law requires that no more than two of them shall belong to one party. They are unpaid, and all they do is to advise on the question of administration, while the engineering and the superintendence of the work are left entirely with the state engineer. The law under which we are

now working was passed six years ago, and it provided for a levy of one-twentieth of a mill on the taxable property of the state, and for the distribution of that fund among the different counties. We have eighty-six counties, and under the law, none can receive more than three per cent. and none less than one-half of one per cent. This one-twentieth of a mill tax levy, with some other resources, has given us a fund of about $80,000 annually during the past three years, which amount has been distributed by the highway commission. The last legislature provided for an increase in the levy to one-quarter of a mill, which will give us for 1912 and 1913 about $320,000 annually, and at the next election in 1912, the people will be called upon to vote on a constitutional amendment providing for a one-mill tax, which will secure a fund of about $1,250,000. The amount given to each county depends on its area and mileage of roads, its necessities, and the interest it takes in its road work, and varies within the limits above noted. Before they can claim anything in the way of state aid, they must submit to the state engineer plans and specifications showing where and how they propose to expend the money.

Now, our state highway commission does not build any roads; that is left to the county, but the administration of the fund, and the supervision of the work, are left to the state engineer's department. We superintend all work that is done by the counties as well as by the state itself, and advise the smaller divisions when called upon by them.

Now, in order to get this money from the state, the county commissioners must put up an equal amount; that is, if we put up $1,000, they must put up $1,000, and the work must be done under the supervision of the state engineer's department.

During the past five years the highway commission has constructed practically nothing in the way of highways—it is all done by the counties—but we have made some sample roads of macadam out of material furnished by convict labor. Mr. Hill spoke of the success of that kind of work in the state of Washington. We have in St. Cloud, in the central part of the state, some large granite quarries close to the State Reformatory and the state

allows the reformatory to furnish inmates of that institution to work at crushing stone. The railroad companies agreed to haul the material free for any distance up to seventy-five miles, and in quantities up to one hundred cars each. We receive the same concession from practically every railroad in the state, and the construction of macadam roads with such materials is directly under our supervision and administration.

Now, as I stated, the difference in the cost of transportation which could be saved on materials going into St. Paul and Minneapolis with a good system of highways would be $250,000 a year. That shows the great saving that can be made by a properly constructed system of highways. But no system can be properly constructed unless there is a suitable superintendent in charge. We have ten or fifteen county superintendents of highways and ten or fifteen road patrols. Our system requires that on every road or bridge constructed by town or county, there shall be direct personal supervision. We have had in our state a great many defective bridges and many roads that failed after the first year or two of travel, by reason of neglect of maintenance. We proposed to do away with that by a system of road patrols. That is one of the most important parts of our system of administration. You gentlemen who have been abroad may have noticed little piles of stone by the roadside, placed there for the use of the road repairers, and we are adopting something similar. We have a system of road patrols whereby we appoint a man, one in each county at present, and give him a stretch of five or six miles. He is always there except at night, and every day, and especially after rain, he is on hand to prevent any damage which may be caused by the rains from extending and getting worse.

In the Scandinavian countries the road is divided into sections, and the individual farmer who owns a tract of land there must take care of a certain strip of road. I noticed in driving over the roads that some strips were only twenty or twenty-five feet in length, and some others were half a mile long.

We have always had trouble here over the question of taxes. Over there they work out part of the taxes under a contract system and they get a dollar's worth of labor

for every dollar's worth of tax. The stone is broken and delivered at the roadside in neat piles of from one-half to one cubic meter, and after inspection is paid for in certificates with which taxes may be paid. In this way they work out their taxes by contract and the state gets dollar for dollar.

In other portions of Europe, they have a different method, but the general plan is the same, the only difference being in the substitution of a definite length of road.

In Scandinavian countries, no man is qualified for the office of county engineer unless he is a graduate of a technical college.

Now there is a question in our state, and that is the question of radial or trunk highways. In the farming communities they said: "We do not want trunk roads. What we want are roads leading from the farms to the markets." The idea of a trunk road emanated from the automobile associations, and that perhaps gave rise to a strong opposition on the part of the agricultural people, who did not want that kind of a road but one which would take them from their farms to their markets. But there is a way of harmonizing these apparently conflicting interests. In our state we have a system of 8,000 or 9,000 miles of state road. Every county is authorized under the law to establish what is called a state road, the object being to put that road, to a certain extent, under the highway commission. And we require that when any money is expended on a state road, the county commission must make an appropriation from year to year to keep that road in good condition.

Now, in order to harmonize these two interests, the farmers and those who want a trunk line system, we encourage the construction of roads which will later form portions of trunk lines. Out of our 8,000 miles, I presume we have 4,000 miles which will eventually become parts of the trunk lines. We encourage the construction of such roads and let the others wait a little while.

We have a bill, passed in the last session of the legislature, called the Elwell bill, which provides for the construction of 1,000 miles of road, for which the state contributes fifty per cent., the county twenty-five, and the town twenty-five. There are applications now in calling

for about 1,000 miles, to be so located as to connect the points of production and the points of sale.

In regard to the convict labor question: Mr. Hill is enthusiastic on that point. We cannot do it, as our convicts are let out by contracts and are used for making shoes, binding twine and farm machinery. And when it was proposed to utilize them for road building, some years ago, it was opposed so violently that we failed to carry our point. A bill was introduced at the last session of the legislature which provided that the superintendent of the reformatory and prison should furnish to the highway commission all the men that could be spared, for highway patrol, but this bill also failed to pass. We find that we have succeeded better on our earth road system by the method of continuous maintenance than we could have if the work had been left to be done at the convenience of some road overseer.

Mr. Hill spoke of some English and other foreign roads. Those roads were built—a large number of them—at a time when there was no road machinery in use. I think when they built the road from Paris to Versailles, that must have been the case, for today you can see the defects caused by imperfect material and improper workmanship. In Norway and Sweden, the roads were constructed by hand labor, and they are, I think, the best in the world, not on account of better materials or better engineering, but on account of the admirable system of maintenance. When we have such a suitable system of maintenance over here, our administration of road affairs will be as nearly perfect as it can be made. (Applause.)

MR. ROSS: I would move, Mr. President, that the paper Mr. Bensel of New York delivered, which was to be discussed in a paper by Mr. J. H. MacDonald, be taken up by Mr. Parker, the President of the association, as Mr. MacDonald is not here. I think Mr. Parker can give us a great deal of information on that subject. He has served on the state highway commission for a number of years, and we would like very much to have him take up this discussion. I make that motion.

PRESIDENT PARKER: Mr. Ross, I will state your motion if you insist. Gentlemen, you have heard the motion. As many as are in favor say Aye. Contrary minded No. It is a unanimous vote. (Applause.)

PRESIDENT PARKER: Gentlemen, If I had known I was to be called upon to make an elaborate statement such as Mr. MacDonald would have made, I should have prepared something that even Mr. Ross could not criticise; nor Mr. Bensel—Mr. Bensel has already left. But the question of maintenance of roads is quite as important, in my opinion, as any other question that comes before the road builders of the country. It is perfectly plain that before automobiles were in use, a road might be maintained under the methods then in vogue at a cost varying from $200 to $500 a mile a year. The automobile came, and in a few months its work would destroy the best water bound macadam road ever built. It was more destructive of macadam road than of gravel or dirt road. And this involved another reconsideration of the question of how to construct a road which would not be destroyed by swift moving automobiles. All the road builders in the world addressed themselves to this question of how to prevent roads from being torn up by high-speed vehicles, in which the tractive force of the machine is so applied as it is in the automobile.

In Paris it was determined that an automobile of any weight whatever did no harm to the macadam road if it did not go beyond fifteen miles an hour; but if it went beyond that speed, the destruction of the road was accomplished more or less quickly, according to the speed and weight of the machine. Now every road builder has put himself to work to find out how he can save his road from the destructive action of automobiles, and the best minds have been employed on this question. And yet today, although we know something, we do not know the whole of it. If you ever see a man who says he has solved this problem, you may set him down as a person lacking in experience. The best builders of roads on this side of the Atlantic, as well as the other side, are unable to tell you how you can solve it conclusively.

We must combine something with the top surface of the road, which will prevent its being disintegrated and partly separated, so that the constituent parts lose their integrity. This has been done in various ways, as you all know. It has been done by the use of bituminous materials, either tar or oil or asphalt, or whatever the material used. It is not necessary for me to tell you

how this is done—and every man with oil or tar to sell will tell you that his is the best method. We all know that while that man may be disinterested, he has a prejudiced point of view, and that if he reversed his allegiance he might have a different point of view.

I will tell you what we have done in Massachusetts. The results there are in a measure satisfactory, and it may interest you to know not only how we get at those results, but also, what is the general administrative plan of the highway commission in Massachusetts, of which commission I have been a member for many years, and of which I am no longer a member.

But there, the brother of Mr. McClintock, the superintendent of roads of this county, who is with you this afternoon, was one of the first members of the highway commission. He was a man trained in road building. He knew the essentials of road building. He knew that a road must be looked after and repaired immediately after it was built. It would not do to let it go for any length of time if there were a sign of injury or destruction. And when the automobiles came, that made it necessary to adopt a definite course. But there was provided in the law that the state must not only build the road, but maintain it.

The state provides for state roads by a bond issue, and the maintenance of those roads is provided for by the legislature, and provided for by direct taxation, so that the maintenance does not accumulate as Mr. Bensel stated. The bonds themselves are provided for in the sinking fund which enables the state, at a certain time, to pay off the bonds as they accumulate, and as the roads are built. That is the method; and each year the highway commission is obliged to apply to the legislature for the maintenance of the roads which it builds.

But there is another source of maintenance in Massachusetts which you would do well to consider, and that is, that all the money derived from automobiles is placed in the hands of the highway commission. For instance, the tax on automobiles in Massachusetts, is at the rate of fifty cents per horse power per year, in multiples of ten, beginning at five and going up. That is put into the treasury of the commonwealth, subject to the draft of the highway commission. And in addition to that amount,

every chauffeur whether private or public is required to pay for his original license and its annual renewal. The revenue from automobiles is between $600,000 and $700,000 annually, and the administration of the automobile division of the highway department should be about $60,000 or $65,000, making a net sum to be applied to the maintenance of roads of about one-half million dollars. That, with what we get from the legislature, provides sufficient money to take care of the roads. The increase from year to year in the tax on automobiles is very large.

That is the method we employ in Massachusetts for maintaining our roads once they are built. And why we do it is this: We have tried, I think, every known thing which any gentleman or company has presented to us in the way of oil or tar or tarvia or asphalt or calcium chloride, or any matters patented or not patented; and we have given them a fair test. Some have been successful and some have been valueless. We found that the same thing might be successful in one place and not so at other places. We built roads at Cape Cod of heavy oil and Cape Cod sand and nothing else. These have been built for six or seven years and show no material signs of wear. We have restored our old macadam roads by patching, and then by applying a coat of asphalt, and oil applied on the road under a pressure of seventy pounds, put on in thin layers. They are immediately covered with stone chips and rolled down with a light roller. As many of those applications are put on as are necessary, and it has produced a road which will wear three years without being touched, even where the traffic is heavy. That has reduced the cost of maintaining roads under the fierce attacks of automobiles to less per mile per year than it was for the old macadam road before the automobiles came in.

I do not mean to say that every road in Massachusetts will bear your inspection and your criticism; but where we have done this as I think it should be done, I have no suggestion for their improvement. Some have been in use for three years, and show no sign of wear. All we used was a quarter of a gallon of oil and some stone chips placed upon the road and then rolled. It is all done by machinery, and all done in a very simple way with trained men and inexpensive processes.

I would like, however, to say that the oil men do not always give us what they profess to give us. The individual who sold the oil, sold it for a good thing, under specifications, but we cannot tell whether he has met the specifications until we have had the analysis made, and the analysis will not be received, perhaps, until after the work is done. So it is pretty difficult to determine whether you have what you expected to buy. So I urge upon the oil men the necessity of standards in their products.

I do not know, gentlemen, that I had better take up any more of your time, but I have given you an outline and taken up some of the space which Mr. MacDonald was to have occupied. I will not say more except to join with you in the discussion which is now permitted—free discussion until four o'clock. That is, you have three-quarters of an hour before the committee makes its report at four o'clock.

MR. POTTS: Mr. Chairman, will you please explain the method of constructing this oil-sand road on Cape Cod?

PRESIDENT PARKER: Briefly it is this: Cape Cod is simply a piled up series of sand layers, of about the same character throughout. That is, it is a fine, but somewhat sharp sand. We first proceeded by shaping up the sand and distributing oil from an ordinary watering cart with a coil of steam pipe in it. In our case we had a boiler which heated the oil, after which it was put into a sprinkling cart, hauled to the road and sprinkled over the sand. It was then harrowed in with a long-tooth harrow, rolled down, stirred up and again rolled down.

MR. POTTS: To what depth did you carry that?

PRESIDENT PARKER: The total depth, after it was finished, was about four inches of oil and sand.

That, however, is not the way we do it now; that is the way we began to do it. We found that the oil and sand would unite to make a road which would carry a ton load without injury, and the wear on it was not perceptible.

I should like, for my own part, to hear what any of you gentlemen have to say on the subject.

MR. REEL: I would like to know, Mr. President, what your improved method is. You stated that the method you described was the one you originally started with.

PRESIDENT PARKER: We have somewhat different methods—more than one method of putting it on the road now. We have a machine which puts the oil or tar on in thin layers—what we call a spraying machine which distributes the oil under high pressure, about a quarter of a gallon to a square yard, and that is put on layer after layer. After the first one is laid, the road will hold up the machine. But the trouble with that is, that you have to go over it and smooth out the places that are made in the sand by the passage of the machine itself. But we are now getting up a machine to shove ahead, which does the work ahead of the motive power.

MR. REEL: How much oil does that require per square yard?

PRESIDENT PARKER: Not less than one gallon, probably more. Where you apply it in thin layers it is slower, it is a building up method of a succession of layers. Mr. McClintock, haven't you something to say?

MR. McCLINTOCK, (County Superintendent of Highways, Monroe County, N. Y.): I would like to hear someone tell of the possibilities of the power truck in the maintenance of roads. It seems to me that this putting a single man and a team out is the most expensive kind of work that can be done, and it would be rather better to organize gangs to be distributed, carried back and forth, utilizing the modern truck. Now, I have not had much experience with this, but lately we took a truck out and tried it. We took it out to do the work which ordinarily is to be done in maintenance. We started out in the afternoon and went down several miles to a gravel pit and got stuck in a sandy hole. It was in the pit and the teamsters—there were thirty or forty of them there hauling gravel—jeered us a great deal, and finally they came and pulled us out with horses. The next day we went with the same outfit into the same pit and fixed up a part of our road and went a mile or two further and fixed up some more, and again at another point, until we had used three tons. Then we ran sixteen miles to a gang at work, dropped some more, and then went to other places. In other words, we were picking up exactly as in maintenance, and we did, say in five hours, a run of thirty-eight miles. I rode as a driver and I enjoyed the ride much better than I have many trips in automo-

biles. We covered a distance of thirty-eight miles, which could not have been done with four or five teams in the same time. It seems that that line of work is bound to be considered and is bound to reduce the cost of maintenance.

PRESIDENT PARKER: I ventured off my subject when I was speaking some time ago. The subject of maintenance is to be discussed by Mr. Owen, and I had not followed closely the line to which I was limited. But Mr. Owen is such a learned man, that I would not touch what he would say, anyway. And so to return to a broad subject—Highway Administration. It is a little different from what I had started out to discuss. Professor Blanchard has handed me a list of speakers, and among them I see the name of Mr. Meeker, State Supervisor of Roads of New Jersey. We would like to hear from Mr. Meeker.

MR. MEEKER: Our method of highway administration in New Jersey is quite different from that in many of the other states. The general idea seems to be that there must be one central power which shall tell you what you shall do, what you shall not do, where you shall work, and where you shall not work. In New Jersey we are rather old fashioned and rather conservative. Our people are great advocates of home rule. They say: We have got to pay for a great portion of these roads, and we should have something to say about where the roads are built. And for that reason our general method is somewhat different from that mentioned by the other gentlemen.

In our state the first steps taken for road improvement are by the people in the particular locality where the road may be situated. From them it goes to the county officials, and from them to the State Highway Department. So the state has no power of initiative whatever, but it has a negative power which is quite strong and sweeping, and it has worked very well, because, as most of you gentlemen know, every man thinks that the road in front of his own house, is the most important piece of road in his state. It is— to him.

But our road department acts as a brake, or governor rather, upon the local demands. The people in a certain locality may say that they want a certain road, and the man who advocates that road may be quite influential in his district. I recall one instance in which a

county official came to the office and wanted a road improved right away. This road began at an improved road which ran north and south, and ended at another improved road running east and west and the proposed improvement was to run like a horseshoe. We asked why he wanted the road. He said he wanted to use the north section to go to a church on Sunday, and the other to go south to business the rest of the week.

The old saying has it that the proof of the pudding is the eating. Under this local option rule we have improved over 1,600 miles of roads with state aid, and as the center of improvement in each case was the county seat, those roads radiate from the county seat towards the boundaries of the county, and in the adjoining county the roads begin at its county seat and run toward its boundary line, thus those roads finally meet and form a continuous system. In this way we have built up a system which connects nearly every county seat in the state. And we also have our main lines crossing the state from New York to Philadelphia. We are peculiarly situated—a small state between two large ones, and between the two greatest centers of population in the East. Therefore, our roads are subjected to a great deal of hard usage.

This plan of laying out a general system of roads to be built is very good for a new state, but whether it is the wisest plan or not is a question which is causing us serious thought. Out of the 1,600 miles of road which we have constructed with state aid, probably 1,000 are of general importance, while 600 miles are purely local roads. They had to be built to satisfy the demands of certain localities whether they were of general use or not. For that reason we do not recommend our system as the best. But it is the most popular, and if you want to get your people interested, we think the New Jersey system is best in a new state. But in states that have been building for some length of time, it is found to be much better to centralize power and have some authority to say where the roads shall or shall not be built.

To meet these changed conditions we are separating our roads into three divisions: First, the state roads which are under the care of the state, and connect large centers of population; second, the county roads radiating from the county seats, and third, the township or local roads.

Our idea is to award the greatest amount of aid to the state, less to the county, and still less to the township, keeping a general supervision over the method of construction in all cases.

Our administrative force is very small, consisting of the commissioner, the supervisor, two assistant supervisors, and some clerks. That makes up our entire state department. The engineering work is done by the engineers of the several counties. They are familiar with local conditions and demands, and also with the soil and the local material, and as a result, we build no one typical standard road. In the northern portion of the state, we build macadam roads, and in the central portion, the greater part are macadam, but there are quite a number built of gravel. And here let me explain what we mean by "gravel." It is not washed gravel or sand and stone mixed, but a mixture of loam and gravel which cements of itself without the addition of any extraneous substance. These are good roads for eight or nine months of the year, but during the rest of the time, they are not so good. In the extreme southern portion of the state, we have oyster shell roads.

These different types arise out of the ideas of the people of the different sections. We use the materials at hand and work with the local authorities. We advise with them and give them the benefit of our experience, and at the same time give their experience, their ideas and their practice due weight. (Applause.)

PRESIDENT PARKER: Is Mr. P. L. Hardison here?

MR. HARDISON, (State Highway Commissioner of Maine): I hardly think I am prepared to make any remarks but it would be out of place to say nothing.

I would like to say that so far, I have been very much interested in the meeting, and I know that I shall receive much benefit from it. That is what I came here for.

In our state, the state of Maine, we are somewhat behind the states of New York and Massachusetts, and in some particular points such as the maintenance of roads, the discussion here, and the ideas which the president has suggested in regard to the maintenance of our macadam roads so as to withstand automobile traction, have been interesting to me. While we have not a large amount of road in the state of Maine, what we do have is

being sadly neglected. In fact, we have no means or funds to draw from at the present time for maintenance. The action of the other states is something I feel interested in, and I would like to have done what can be done in the future for the state of Maine. I hope that will be taken up soon.

At the last session of the legislature an act was passed taxing automobiles, and that fund may be used for maintenance and construction, either one. That will help us out considerably. There are some things which I hope to learn from your members as they discuss these various subjects.

I thank you very much for calling upon me. Mr. President.

PRESIDENT PARKER: We will now hear from M. Nelson P. Lewis, Chief Engineer, Board of Estimate and Apportionment, of New York City.

MR. LEWIS: Mr. Chariman and Gentlemen:— I believe that this question of administration and organization for highway work is one of the most important topics which can be discussed at this convention. Both of the gentlemen who introduced the subject have left the room, but some of those present, while deeply interested, may feel it imprudent to discuss it frankly. I want to dissent from some of the views expressed by the State Engineer in his presentation of the subject, and I am sorry that he is not now present, as I have a sincere respect for him, not only on account of his official position, but as an old friend.

I believe in continuity of policy, continuity of purpose, and continuity of personnel in highway administration, whether in state, town, county or city. I doubt very much the beneficial effect of the highway administrator going to the people for a vote of confidence at a general election. I doubt the value of the humility which would be promoted by this policy.

There was a good old padre who had a great reputation for humility. His father was a fisherman and he kept a fish net strung across his study wall to remind him of his humble origin. He became a bishop, and still the net hung there. He became an archbishop and the fish net was still there. It was dusted occasionally, but it still hung on the wall. He finally was made a cardinal. One of his friends calling upon him after his promotion

noticed that the net was not to be seen; and he asked "How is it that the fish net that was here so long is no longer visible?" The cardinal replied, "What do I want with a net now? I have caught the fish?"

To tell the truth, I have very little confidence in results attained by the popular election of a professional man to an office requiring the exercise of professional ability.

Let me give you an instance of the way in which candidates are sometimes selected for state offices. When a ticket was being made up in New York state not many years ago the party conventions had filled all of the places, except that of the state engineer. For this place there seemed to be no demand. Finally they turned to one of the leaders and said "You can name the candidate for state engineer." The leader addressed proceeded to call up a man in his town on the telephone and he said "Will you take a nomination for state engineer and surveyor?" The man at the other end, thinking he was joking, replied, "Nothing less than governor for me." The leader said, "I am not joking. You can have it if you say the word." And the reply was, "I will take it." He was not only nominated, but elected by a substantial majority. This may be an exceptional case, but I think it will justify my statement that in selecting a man for professional service, nomination in a party convention and election at large is not a very satisfactory procedure.

I had hoped that you gentlemen from various states would give us some observations or experience as to whether periodical reorganizations in highway administration have been conducive to efficiency or not.

If we were to have a commission, say of three, suppose the term of one of the commissioners expired under each state administration. For instance, in this state the term would be six years, and it would fall to the lot of each succeeding governor to name one of these commissioners. Don't you think there would be more consistency in our policies and greater continuity of purpose, and that there would be developed greater efficiency than under this method of going to the people every two years?

Now I am not saying anything in criticism of the policy of the present highway administration in this state, but the theory is, in my opinion, radically wrong. I believe that much better results will be secured if we can insure

continuity of purpose, continuity of policy, and even continuity of personnel. (Applause.)

PRESIDENT PARKER: I think what Mr. Lewis has said is very pertinent and to the point, and the suggestion as to a choice by the people is sometimes rather amusing. In Massachusetts this year during the annual election, some persons put up the name of Murphy as a democratic candidate in a certain town, and "Murphy" was elected. Nobody knew "Murphy" for the very simple reason that there is no such person in that town. That is an actual occurrence in a Massachusetts town this year. It shows that a rather dangerous way of selecting a technical man to do technical work is by having him selected by popular vote.

The method employed with us is to have three commissioners appointed by the governor, who have entire control of the situation, both as to expenditures in laying out and the subsequent maintenance. That way has been found to be fairly good. But my view is that any commission that is administrative and constructive should consist of not over one man, and that man should be selected for the value of his services, and not for his political work. Put the responsibility on one man and not on three. Where the functions are judicial, three men or even more, might be better, but where the functions are strictly constructive, my view is that one man, properly qualified, is better than more.

I want to take this opportunity to notify those who want to become members of this association, that it is the intention of the directors to publish the papers and discussion presented at this convention in a single volume, and that these are to be distributed to all those who are registered as members. The cost of membership is two dollars, which as a subscription is simply meant to pay the actual cost of carrying on this organization. It is a purely popular one for the public good, and is made up of the practical men engaged in the building of roads, whether they are engineers, supervisors, contractors, oil men or anything else. These are the men that carry on this organization, and the purpose is to have a force which will do certain things for the public good. I can say to you that if you examine the list of directors of this organization, you will find a sufficient indication of the type

of men who are now your officers, and a sufficient guarantee that what they do will be along the lines which I have indicated to you, and that it will be well done.

I want to say that the date of the business meeting and reports of committees has been changed from Friday to Wednesday, at 4 p. m., the purpose being to let everyone who desires to do so, take part in that meeting, even though they do not want to stay here the four days.

I think that is all for today and I declare the session closed.

THIRD SESSION

Wednesday Forenoon, November 15

PRESIDENT PARKER: Gentlemen, this meeting will now come to order.

SAMUEL HILL (Honorary Life President of the Washington Good Roads Association): Mr. President, may I present the following resolutions which I hope in due course will be referred to the committee on resolutions and, on their report, acted upon.

"Be it resolved by the American Road Builders' Association in congress assembled:

"First, that this Association believes that the matter of education in road building is of primary importance, and to that end, it hereby appoints a committee of three to be designated by the Chair, whose duty it shall be to lay before the President of the United States, Congress and the Secretary of Agriculture, the request of this Association. urging the importance of establishing in the Military Academy at West Point, and in the several agricultural colleges throughout the United States, a chair or department to be occupied by a man versed in the art of scientific road building, and to use all reasonable endeavor to have the intent of this resolution carried into effect in the manner above designated.

"Second, that this committee shall be empowered and directed through the channels above named or otherwise, to ascertain what steps are being taken by the United States government, to carry out the provisions of Article 8 of the Constitution of the United States, which provides for the establishment of post offices and post roads.

"Third, that it shall be the duty of this committee to ascertain what sums of money, if any, are now being spent by the National Government, for the construction of government highways, and to ascertain what money has been appropriated by Congress and placed in the hands of the Department of Agriculture for the improvement of highways, or instruction in the art of building same; and whether in the opinion of such committee, the sums so appropriated are being spent to the best advantage.

"Fourth, that it shall be the duty of this committee to make a report to the executive committee of the American Road Builders' Association, and also to the members of such Association, through the official organ of this Association, and if necessary, to urge upon Congress or other proper governmental authority, to take such steps as may be necessary and conducive to the advancement of the cause of highway improvement."

These resolutions I present with the idea of having the proper governmental authority designate that scientific road making should be established and ordered in the government school at West Point and also in the agricultural colleges throughout the United States, because I think it has gotten down to the basic principles, gentlemen, and I think the farmer is the basis of our social system.

PRESIDENT PARKER: This resolution will be placed in the hands of the committee on resolutions, which will report at the proper time.

The next matter before the congress will be a paper by Mr. Nelson P. Lewis, Chief Engineer of the Board of Estimate and Apportionment, of the City of New York, the paper being upon the subject of "Adaptability of Roads and Pavements to Local Conditions."

I value this paper of his very highly, and I nave no doubt you all will. And after Mr. McLean has made his statement, you will be permitted to discuss the subject from the floor. Mr. Lewis, Gentlemen. (Applause.)

MR. LEWIS: Mr. President and Gentlemen of the Convention:—I fear that after the very kind introduction by our President, you will expect entirely too much, because from the very nature of the subject, this must be a very superficial statement of the question of "Adaptability of Roads and Pavements to Local Conditions"; and I have endeavored to deal simply with a few types. I did not

have the temerity to discuss the different kinds of proprietary articles, and if some of our friends here—some of our exhibitors—feel that I have not enumerated or emphasized the value of their own products, I cannot help that.

ADAPTABILITY OF ROADS AND PAVEMENTS TO LOCAL CONDITIONS

By NELSON P. LEWIS

Chief Engineer, Board of Estimate and Apportionment, New York City

Various types of road surfaces or pavements are recognized as possessing different qualities in varying degrees. The most conspicuous physical qualities are durability, smoothness or light resistance to traffic, slipperiness, facility of repair, and sanitary features. In addition to these there is the most important quality of economy, not low first cost, but the lowest annual cost for construction and maintenance when spread over the entire period of the life of the pavement.

Each one of these qualities may involve several considerations which it is unnecessary to discuss in a paper upon the particular subject assigned to this session. The writer will simply consider the methods commonly used in determining the kind of roads to be built—the considerations which should determine the selection—and emphasize the need of a more careful study of the adaptability and suitability of the different kinds of road surfaces to the particular highway to be improved.

There has always been a disposition to draw a sharp distinction between streets and roads, the former being considered as belonging to cities and large towns and the latter to villages and rural districts. They are, however, all highways, and the same considerations of suitability and economy in the selection of the road surface should apply to both. There are many village streets and interurban highways which sustain a far greater traffic, both in number of vehicles and in tonnage, than do the residential streets which happen to lie within the red lines indicating the corporate limits of a great city. It is true that in the city street the need of surface drainage requires a nicer adjustment of grades, a more sharply defined gutter, and an impervious gutter pavement. It is also true that the abutting

property is so valuable that it can by direct assessment meet the cost of a more costly road surface than is possible for the much longer suburban or country roads bordered by land, the value of which is trifling in comparison with that fronting upon the most modest of city streets.

How has a determination usually been made as to the kind of road surface to be placed upon a highway which is to be improved? Has there been a careful consideration of the local conditions, the rate of grade, the amount and character of the traffic which passes over the highway or which will probably be attracted to it by reason of the proposed improvement, the likelihood of disturbance of the surface in order to repair existing or install new underground structures, the annual charges due to first cost and maintenance, etc.? Has not this important question been determined in most cases by the preferences or prejudices of some of the abutting owners, whose qualifications for the task it would be hard to discover, or by those whose alleged opinions have been judiciously accelerated by an enterprising agent of some particular kind of pavement?

Such a policy would not be considered for a moment in securing a design for a system of sewerage or determining a source of water supply. It is recognized that our water and drainage systems are intimately connected with the public health and that of the individual family, so that questions relating to them are by common consent delegated to experts for solution. The construction and care of our highways are commonly supposed to concern only our convenience and our taxes, and upon these questions every taxpayer considers himself an expert.

Since Tresaguet, in France, and Telford and McAdam, in Great Britain, showed, about a century and a half ago, that roads of broken stone were capable of carrying heavy loads and could be made practically impervious to water and proof against the action of frost, the broken stone road has been considered the highest type of country and village highway, and until recently it has been frequently found in city streets. In Great Britain such roads are extensively used by heavy traction engines hauling trains of loaded wagons. This use of traction engines on rural highways is rapidly increasing, Mr. W. J. Taylor, County Surveyor of Hampshire, having estimated that there were in use in 1908 about 8,500 such engines on the highways of England and Wales, or about one to every 3¼ miles of main road.

By the beginning of the present century progressive countries had set about constructing a more or less complete system of water bound macadam highways connecting the various centers of population. Within the last decade has appeared the high speed road locomotive, or automobile, and it soon became apparent that, while water bound stone roads stood up fairly well under rolling loads, they were not calculated to resist the action of driving wheels, and it is now universally recognized that a different kind of binding material must be used. The technique of modern bituminous macadam construction does not come within the limited scope of this paper, and no further reference will be made to it except as a modern type of road surface it being assumed that very little macadam is likely to be laid in the future without the use of a bituminous binding material either by the mixing method or by surface application. While the new type of macadam is calculated to resist the action of self driven vehicles, the commercial use of such vehicles, which is just beginning in this country, both as to the number of vehicles and their carrying capacity, will doubtless increase very rapidly, and this is one of the chief considerations which in the writer's opinion should govern the determination of the type of road to be constructed. The English traction engines already referred to, while slow moving, are very heavy and haul wagons with correspondingly heavy loads. This kind of traffic will necessitate the provision of strong surfaces and foundations, and it has been predicted that it will be necessary to place under macadam roads which are likely to be subjected to exceptionally heavy traffic substantial concrete foundations.

There may in some cases be local prejudice against considering adaptability to motor car traffic in determining the kind of construction to be employed, but it must be remembered that in the state of New York owners of automobiles, during the current year, will pay into the highway funds of the state in the form of registration and license fees the sum of $900,000, or enough to pay interest and sinking fund on some $18,000,000. Moreover, the receipts from this source will doubtless increase, rather than decrease. If motor trucks and traction engines are to come into general use, it would be manifestly fair to impose an additional tax upon all vehicles designed for a load of, say, 2,500 pounds or more on each wheel.

Without enumerating in detail the different kinds of pavement available for use in road construction, they may be classified under five separate types, as follows:

1. Broken stone with bituminous binder, or roads of the macadam type.

2. Finely divided or pulverized mineral matter with bituminous binder, which for lack of a better name may be called roads of the asphalt type.

3. Stone blocks of various sizes laid in courses or in some regular pattern.

4. Artificial blocks in the form of brick, slag, cement, concrete or bituminous concrete.

5. Sheet or monolithic concrete.

The problem with which we are confronted at the present time is the creation of a great system of good highways, the aggregate mileage of which will be enormous. Nearly all of these highways will be in rural districts, where the cost of their construction cannot be assessed upon the abutting property. The expense must, therefore, be met by the state or by the state, county and town jointly. The money must be borrowed through the issue of bonds or must be raised when needed by direct taxation. While the annual cost of maintaining these roads will be a serious burden, which should be reduced to the lowest possible amount consistent with efficiency, and while the type of road to be built should be determined with regard to ease and economy of maintenance, the selection of the type of surface will in most cases be controlled by considerations of first cost. Where local stone is available for the entire road or even for the bottom course, and where exceptionally heavy traffic is not anticipated, there will be no hesitation in selecting type No. 1, or macadam with a bituminous binder. If the traffic is considerable, and if a large proportion of it consists of motor cars, the slight additional expense of employing the mixing method will be amply justified, while if the traffic is light and slow moving, the somewhat cheaper, but in the writer's opinion less effective, plan of surface application may answer the purpose. This type of road, where local stone can be used, will permit of the building of the greatest mileage with the funds available.

There are certain sections where there is no native stone available for road building and maintenance, and where the cost of transporting it from distant quarries would be so

great as to make a stone road unduly expensive. In such cases the most economical surface to adopt would be type No. 4, or one of artificial blocks. In sections which are devoid of stone it frequently happens that there is material from which excellent paving brick can be made, but if bricks are not available, other blocks may be used. These may be of slag or cement or bituminous concrete, while sand or gravel must be supplied as a bed for the bricks or blocks. and underdraining will in most cases be essential. In towns which are so located, a road surface of the asphalt type may be used, but this pavement as commonly laid requires a concrete or other substantial foundation. It is not improbable that a pavement of the asphalt type will be developed in which the mineral matter, instead of stone or sand, will be loam or clay. The writer has seen samples of such a road surface, which appear tough, malleable and non-slippery, while if suitable material is readily accessible it is predicted that its cost will be little more than that of a good macadam road.

It is generally recognized that the most durable of all pavements and the one requiring a minimum of expenditure for repairs is stone block. Under horse drawn vehicles with steel tires it is rough and very noisy, and both the horse and the steel tire will be with us for many years. It was but a few years ago that granite or other stone block was considered a proper pavement to be laid upon such streets as Fifth avenue in New York or Euclid avenue in Cleveland, but whether it is due to a greater appreciation of quiet or to more susceptible nerves, such pavements are now considered entirely unsuited to thickly settled communities, except where there is an intensive traffic and in streets largely given over to business and where noise is not a serious objection. The writer believes that stone blocks have not been given the consideration which they deserve for roads where the traffic will be heavy, where noise will not be a nuisance, and where the blocks once laid need not be disturbed. A type of road surface which has given very good results in Europe is that known as "Kleinpfiaster" and is a pavement formed of stone blocks approximately cubical in shape, about 3 ins. square on top, and 3 to 4 ins. in depth, laid in concentric rings or curves with different centers, giving an arch or mosaic effect in appearance. This pavement gives a good foothold for horses, offers little resistance to traffic, is

much less noisy than stone blocks laid in straight courses at right angles to the direction of travel, and offers an excellent surface for motor traffic. The cost of such a pavement laid over an old macadam and including the adjustment of the surface is said to be about the same as that of ordinary granite block. On many of the interurban highways of Germany this pavement has been laid to a width of from 15 to 18 ft., and is giving very satisfactory results, while its relative noiselessness makes it unobjectionable on highways where the abutting property is well built up. It is said that pavements of this type have been in use on heavily traveled roads for 25 years with practically no expenditure for repairs. Both the ordinary stone block and "Kleinpflaster" have claims to consideration on our rural highways which have not heretofore been recognized.

A type of pavement which has thus far had but limited use is that of cement concrete. Some of this pavement when well constructed of sufficient thickness and on an unyielding foundation has given excellent service, although owing to the personal element which appears to make it very hard to secure uniform results in the mixing and laying of concrete, it is difficult, if not impossible, to guarantee success. If too smooth, these pavements are unduly slippery under certain weather conditions, and they are not suitable, therefore, for heavy grades. It is essential that the concrete should be given ample time to set before traffic is allowed upon it. This is of the utmost importance, and it might not be extravagant to say that each additional day after apparent setting that all traffic can be excluded may add a year to the probable life of the pavement. The latest development in the line of concrete pavements is what is known as oil concrete, in which a bituminous oil is added to the concrete before it is laid or is applied to the surface of the concrete after it is well set, as a waterproofing coat. If in addition to the surface application of oil there also be added a coating of fine stone or screenings which is renewed as it wears away, a protecting surface may be furnished which will make concrete pavements more generally satisfactory than they have been heretofore.

The writer cannot attempt to specify under precisely what conditions any one of the types of road surfaces which have been enumerated should be adopted. The object of the paper is to point out in a general way the adaptability of

the several different kinds of pavements to local conditions and to urge a more careful consideration of their availability instead of assuming that all country or village roads or all parts of any particular highway should be treated in the same way as every other highway.

A few years ago the streets of our cities and towns were, with few exceptions, far better adapted to all kinds of vehicular traffic than were our rural highways. Attention has lately been focused upon the latter, and the improvement of their condition is so marked that the statement is not infrequent that in a motor car trip of hundreds of miles the only bad roads encountered have been in our large cities. A discussion of the adaptability of pavements should not, therefore, exclude the consideration of city streets. While the annual expense of constructing, maintaining and renewing pavements in a large city is very great, the first consideration is not, or should not be, one of cost. The health, comfort and convenience of city dwellers is so dependent upon smooth, clean, sanitary and quiet pavements that they are cheap at almost any price. In paving city streets it is customary to impose upon the abutting property the cost of at least one pavement, and it is but fair and equitable that the pavement so assessed should be as durable as possible and should be placed upon a substantial foundation which will be available for those which may be subsequently laid; in fact, it would not be unreasonable to say that the underlying foundation is the real pavement and the visible surface only the protection for it. There are some streets where quiet is such an important consideration that a short lived pavement which is fairly noiseless is much preferred to one which is more durable and therefore cheaper in the end. It is this aversion to noise, doubtless, that has induced Paris and London to use wooden block, which is the most quiet of all pavements, but which as laid in these cities must be renewed every few years, with the attendant inconvenience and discomfort inseparable from such an operation. It may be asked why wooden block was not included among the kinds of pavements available for ordinary highways. It was purposely omitted because it is essentially and, in the writer's judgment, exclusively a city pavement requiring an especially unyielding foundation, while its cost is too great for use elsewhere. It might, in fact, be called a pavement "de luxe." The money value of a clean and quiet pavement

on a street devoted to office buildings or high class hotels and residences is so great that the cost of frequent renewals if imposed upon the owners in the shape of assessment, would be a small price to pay for the luxury in view of the greater rental value of offices and rooms, while in front of schools, hospitals and churches, such pavements are essential if the institutions are to properly perform the functions for which they are designed. The word renewals as above used will not be construed as applying to that more or less constant operation so much in evidence in our American cities which consists in the restoration of the surface over numerous subsurface structures with which the modern city streets are filled. Suggestions for a remedy for this trouble, which appears to be chronic in most cities, is not within the scope of this paper, but a recognition of its existence will make it wise to take into account the facility with which openings can be repaved without permanent mutilation, in considering the suitability of a pavement for a city street.

Some of the most serious problems in highway construction and maintenance are caused by the presence of surface railway tracks within the paved area of the highway. Many suburban and country roads have been almost ruined for ordinary traffic by the laying of such tracks. The desire for high speed has lately resulted in the location of such railways on private rights of way or at least well without the traveled roadway if located within the highway limits. Attempts have been made to lay and maintain macadam along and between rails. The results have nearly always been failures and have rarely, if ever, been even moderately successful. Stone, brick, or some other form of block seem to be the only suitable materials for such use. If the rails are heavy and well laid, the joints can be filled with cement or pitch, and there will be little dust. If the track construction is less substantial, and frequent repairs and adjustment are necessary, sand joints will answer the purpose. In city streets which are paved with asphalt or other smooth pavements, attempts are frequently made to use the same kind of pavements between the tracks and rails with the special object of making them as inconspicuous as possible.

Why pretend that there are no tracks and use a pavement entirely unsuited for the purpose? It is better to recognize them as a proper and necessary part of many of our city streets and place between them a pavement which will best

meet the exacting conditions without regard to which kind may be used on the sides of the street. For this purpose nothing seems better suited than well cut stone blocks laid upon an unyielding foundation with cement grouted joints, while if quiet is especially desired properly treated wooden blocks will give excellent results. Where stone or wooden blocks are unduly expensive, the best quality of brick or slag blocks will be an acceptable substitute, but they should be laid in the most substantial manner possible.

Our highways are designed primarily for vehicular traffic, but the street railway is a necessity. The right to lay tracks in our public streets is a very valuable one, and the corporations enjoying such rights can reasonably be expected to lay and maintain pavements within the space occupied by them in the best possible manner and at their own expense.

The conclusions which have been reached may be briefly summarized as follows:

1. In country highways the chief consideration will be first cost, and the cheapest suitable material which is available must be used.

2. In roads where heavy traffic and excessive wheel loads are likely the most durable material should be employed and the foundation should be capable of sustaining very heavy loads.

3. Where noise is not a serious objection, stone block will be the most durable and economical road surface under heavy traffic.

4. In suburban towns and residential streets a quiet and dustless road surface will be well worth the additional expense involved.

5. In city streets the consideration of cost can properly be subordinated to sanitary qualities, quiet and cleanliness.

6. Between and along surface railway tracks the pavement should be especially adapted to the exacting conditions and should be laid and properly maintained by the railway company without public expense.

PRESIDENT PARKER: Gentlemen, I have observed that where everybody in a room keeps his eyes fixed on the speaker for a considerable period of time, it is because they are very much interested in what the speaker is say-

ing; and I noticed that during the time Mr. Lewis was talking that was the case here.

The next thing on the program will be the discussion of the paper by Mr. Lewis, and Mr. W. A. McLean will open that discussion. I think most of you know Mr. McLean by reputation—he is the Provincial Engineer of the Province of Ontario and succeeded Mr. Campbell. He is a man who is known throughout Canada as a scientific builder of roads. He will now say something to you in which you will be very much interested. Mr. McLean, Gentlemen. (Applause.)

MR. McLEAN: The subject before us is one of wide range and application, and the difficulty of doing justice to it in restricted time and space is necessarily great. Permit me, therefore, to congratulate the previous speaker, upon his lucid and interesting address, and upon his success in condensing, within the limits of a paper, so much information and experience relating to the adaptability of roads and pavements to local conditions.

A study of road conditions in various countries of the world will show a remarkable similarity in their several stages of road improvement, and in the problems which have confronted each. Throughout all, certain general principles are apparent, although local circumstances may require or permit a considerable variation in detail. These variations are, in general, more superficial than otherwise, and the underlying principles are in most cases, of universal application. Thus on this continent we say, "Too many cooks spoil the broth," but in China they say, "Too many cooks spoil the dog." The general truth that too many cooks are an evil is taught in either case, and "broth" or "dog" are merely the local details. General truths are the same the world over, and it is important that, on the one side, we do not deny the usefulness of the general principle because of varying local applications; and on the other hand, that we do not render a failure, the general truth by neglecting to adapt details to local conditions.

Let me emphasize a matter alluded to by the previous speaker—the selection of paving material for particular streets and roads, according to the preferences or prejudices of some of the abutting owners, "judiciously accelerated" by the enterprise of a salesman representing some

particular kind of pavement. Most emphatically, "Too many engineers will spoil the pavement." It is a basic truth in all good business management, that responsibility should be centralized in order that full credit or blame may be placed where due. How can this be possible when paving materials are selected by the people or by councillors in opposition to or without the recommendation of their engineer? This is an evil in Canada as well as in the United States, and one which, solely in the public interest, should be strenuously combated. It is right that the preferences of the people should be made known; it is right that the taxpayers should express their views, and that these preferences and views should be given impartial and wise consideration by the engineer. But the engineer is employed as an expert, and as regards paving, the selection of the most suitable material for a given street or locality, should be one of his most important functions. Responsibility should be fixed upon him in this regard, and if he is inefficient and his selections are plainly unwise, another engineer should be sought. But the public, in its own interest, should be the last to relieve the engineer of this most important duty—the final selection of the most suitable paving material for each street under his jurisdiction.

Somewhat allied to this is a rule of procedure in English practice, that, in letting contracts, purchasing material, and making appointments, the tenders and applications can be made only in open council or committee, and any agent or company or applicant personally approaching a councillor, or official of the council, is absolutely disqualified. That is an ideal toward which it is to be hoped public opinion will tend in all parts of the world.

Climate is an extremely important factor in selecting a paving material or determining the details of construction for any given locality. While most paving materials are of universal use, if properly employed with due regard to local conditions, these varying local conditions should be carefully studied and compared. The lack of scientific data in this regard is a serious deficiency on this continent.

Climatic differences of temperature, moisture and wind in all combinations, materially influence the amount and

method of drainage to be adopted. For example, if the subsoil and situation of a road are such that the natural soil is saturated and filled by the autumn rains and the melting of snow during the winter, and if this is acted upon and expanded by frost during the winter to a depth of three or four feet, as in Canada and the northern states, it is manifest that a very weak condition of the subsoil must exist when the spring thaws and freshets come. The foundation of the road may in this way become a quagmire for two or three weeks in the spring, during which time traffic will break through or partially disrupt any stone surface that could reasonably be applied. Under such climatic conditions, the need for careful underdrainage of the subsoil is manifestly much greater than in such a climate as that of England, where the frost penetrates only three or four inches into the ground. A mild climate having long periods of heavy rain may develop very similar conditions, though without the added difficulty of expansion by frost, or an impervious stratum of ice below the surface.

In the use of bituminous binders we have much to learn from other countries, particularly England, France and Germany, but any deductions should be made with full consideration of climatic and other differences. Thus in England tar is widely used for road purposes by spraying, by penetration, by the matrix, and by the mixing processes. But the extremes of temperature and the dry atmosphere of this continent present influences which do not exist in the more uniform and moist climate of Great Britain. Experience with tar in Canada has shown that it will resist successfully the climatic conditions, but the numerous failures have as clearly shown the necessity for a more scientific use with a view to climatic differences, demanding a careful study of methods of manufacture, of distillation, of proportioning the tar, pitch and creosote oil, and of selecting and grading the mineral aggregate. More frequent surface painting and gritting may also be one of the means for overcoming the influence of hotter and dryer climatic conditions.

First cost is often, necessarily, a determining factor, but as pointed out by Mr. Lewis, the ultimate cost at the end of the life of the pavement should, if possible, for true economy, be the most considered. The cost of pavements varies

greatly according to locality, and an economical material in one district may be extravagant in another, owing to relative difference in prices. In Cleveland, vitrified brick (an excellent paving material for many situations) cost $8 per M, while at Toronto the cost is $18 per M. Roads of local gravel, with short haul, may in cases be had for one-third of the cost of broken stone brought by rail; so that a gravel road, even if it has to be heavily resurfaced every four or five years, is probably, under such circumstances, a more truly economical road than broken stone would be.

The local cost and efficiency of labor is a factor which may favor or cause the rejection of an otherwise suitable paving material, which elsewhere can be economically laid. There is often a considerable range in this regard in short distances, while as between separated countries or regions the variation may be exceedingly marked. Wages are generally higher in the cities than in the country; are lower in Europe than on this continent, and are usually lower in Southern than in Northern countries, so that methods and materials should be varied accordingly.

Road construction has been criticised from time to time because of large bond issues, and the economic value of large expenditures has been questioned. Very great care must be taken in the local adaptation of road making materials in order that this criticism may not be justified. The use of heavy foundations, bituminous binders and other first-class materials is no doubt justifiable and essential on heavily traveled suburban and main interurban highways—the class of road which is or should become of national, or state, or occasionally of county importance. But this will ordinarily apply to a comparatively small percentage of the total highway system, and a road that is too good, and too costly, for the amount of traffic, is as much an economic blunder as bad roads. But all roads of the country need improvement. It is as necessary that the 90 or 95 per cent. of less traveled township and country roads be made proportionately good by grading, draining and surfacing, as that the 5 or 10 per cent. of trunk roads be built, but care must be taken that costly design suitable only for the latter, be not carried into the division where cheaper construction would be satisfactorily serviceable. Construction adapted to location and traffic, with proper regard to future requirements, is of vital necessity.

Let it not be supposed that I am one of those who believe that, to the present time, there has been any serious extravagance in country road building. On the contrary, we are much in the position of the darky who was heard grumbling to himself as he walked along the street.

"Well, Sam," he was asked by a man who overtook him, "what are you so grouchy about?"

"Oh, dat wife o'mine, boss, she's all's wantin' money. Mornin', noon an' night, every time I go in or out of the house, it's money, money, money—all's asting for it."

"That sounds pretty extravagant, Sam. What does she spend it all on?"

"Oh, I don't know, boss. I ain't done give her any yet."

That is the real situation. In very few localities have we commenced to spend on this important public work the amount which could profitably be invested.

PRESIDENT PARKER: Mr. McLean has given you a characteristic speech, and one which is full of good suggestions and wisdom; and I consider we are very much indebted to him.

I am going to call upon a representative of the great State of New York, one who has done perhaps as much as any other individual in the state to develop the road system as a whole, and I think every one of you will be delighted to hear what Mr. Frank D. Lyon, Second Deputy, New York State Commission of Highways, will say to you.

MR. LYON:

"A wise old owl lived in an oak;
The more he saw the less he spoke;
The less he spoke the more he heard;
I thought I could be somewhat like this wise old bird."

I had not expected that I would be called upon to enter into this discussion and I am in a somewhat embarrassing position in attempting to follow up the wonderfully well prepared papers and well presented arguments made on the part of the gentlemen who have preceded me.

Regarding Mr. Lewis' speech I can only supplement his remarks in some particulars. It is useless to contemplate or to undertake the solution of problems entering into this question of highway improvement without first providing by statute a means by which the traffic or the carrying of commodities may be regulated to such a degree that the

thoughtful and considerate users of the highways may be protected in their rights, and the thoughtless and destructive forces may be restrained. The improved highways of the state of New York generally are calculated to withstand a linear inch pressure of not to exceed three or four hundred pounds, which means per inch of tire or carrying surface of loaded vehicles, and the permitting of hauling loads in excess of this, is destructive. The growth of the improvement of the highways of this state has called into existence a traffic which road builders had not contemplated. This traffic exists in various forms—the carrying of excessive loads upon narrow tires of horse-drawn vehicles, also of motor trucks in which load and motor are combined in one vehicle. There are today being propelled over the roads of this state loads of such weight and upon vehicles of such character that no road could be built to withstand the traffic for any great length of time, and the time has come for this state to determine the weight and character of loads and vehicles for which it is considered wise to attempt to build roads, and to forbid the use of roads so built to any other kind of traffic. Unless immediate steps are taken to protect the system of roads already improved and to stop abuses, the spread of the evils mentioned will result in so much destruction that the question of the cost of construction will be simply a pigmy as compared with the cost of maintenance.

The remarks of the two gentlemen who have preceded me, with the possible exception of the gentleman from Canada, seem to be directed toward those problems which enter into the question of the construction of highways contigious to large centers of population, and which will be called upon to carry concentrated traffic. Their thoughts did not seem to include those questions which I believe to be of as great or greater importance, namely, the development of a broad and comprehensive plan of highway improvement of a character suitable to the local conditions and local requirements. It is my opinion that those who have been interested, and are today interested in this question of highway improvement have not given sufficient thought or consideration to a generally improved condition.

The plan adopted by this state, and I think by all the other states, has been erroneous and ineffective in that in no instance in this country has provision been made for

comprehensive supervision of the work, and for a broad, comprehensive plan of highway improvement. The popular idea has been directed toward the improvement of some particular section in some particular way, and no thought or attention paid to a generally improved condition. The popular thought has been toward the entering of a little dot of improvement in the vast sea of highways, without any regard to the future requirements, and the possibility that contemporary improvements in a less degree and of a cheaper nature can be carried on directly with those of a greater cost and smaller magnitude has never entered the popular mind.

The character of the construction and improvement of a state highway should be that which is suited to local requirements and calculated to be of such a nature as to be suited to the needs of the traffic to which it would naturally be subjected. The construction of a highway costing from $15,000 to $18,000 per mile in a locality where an expenditure of $500, $1,000, $2,000, $3,000 or possibly $5,000 per mile would carry the traffic just as satisfactorily, cannot, in my judgment, be regarded by any thinking man as a wise policy.

The gentleman from Canada touched upon a very vital point which, up to the present time, I have not heard considered. In all my experience in addressing various road meetings of this character I have not heard anyone treat the subject of drainage as thoroughly as did Mr. Campbell of Canada. You may talk about the kind, quality and class of material to be used in the construction of highways all you want to, but I want to say that there are three great propositions in this question of highway improvement, and "The first is drainage, the second is drainage, and the third is drainage!" (Applause.)

I, personally, would much prefer a well drained, ordinary earth road to a poorly drained macadam road. There is no road on the face of the earth so pleasant or agreeable to travel over as an earth road when that earth road is good.

I see before me many of my old friends, particularly those of New York state, who have heard me discuss certain problems entering into this question in the past, but I am assured that there are many delegates here today who are not conversant with the New York state system of high-

way improvement, and so I deem it well for the benefit of those from other parts of the United States and from the provinces of Canada, that I should touch upon another subject which will not be discussed today or at any other time during this congress.

In the state of New York we have 80,000 miles of public highways, and every mile is under the immediate care and supervision of the state highway authorities. My duty as Deputy relates particularly to the improvement of the roads other than those which have been constructed or are to be constructed as a result of the $50,000,000 bond issue. In other words, my whole time and attention have been devoted toward devising a plan by which a generally improved condition of the highways may be undertaken. Therefore, my thoughts are not directed toward the centralized community, or the citizens of such communities, but I am compelled to think of Bill Jones who lives in the most remote corner of a town in a county and on a farm situated on a short stretch of road a mile in length. Bill possibly may have one neighbor living on the same road and about all the traffic that this one mile of road is called upon to carry is the produce which Bill wishes to deliver to his local market. Bill has a productive farm; Bill pays taxes and he must deliver his produce to his local market in competition with his neighbors. Bill is entitled to a just consideration of the improvement of that single mile of highway.

In the administration of highway affairs of the state of New York, we have a superintendent of highways, Mr. C. Gordon Reel, who is at the head of the State Highway Department, but the department is governed by a commission made up of the State Superintendent of Public Works and the State Engineer and Surveyor. Our highway system is divided into three classes: First, state roads, that is roads which are to be built by the state without any aid from the town or county through which such roads pass; second, county highways, which are to be built by the state, but with the aid of the county and town through which they pass; third, town highways, roads improved, repaired or maintained by the town, with the aid of the state, in accordance with the provisions of law and the rules and regulations formulated by the State Highway Commission.

As I have heretofore stated, the public mind in this

state is directed toward the improvement of the so-called state and county highways, and little thought or attention has been paid to the system for the improvement of town highways, the state and county highways being considered to present the larger problem. Last year an appropriation of about $10,000,000 for the improvement of state and county highways was made from the bond issue, but during the same year, in addition to this amount, $8,500,000 was expended in the improvement of town highways and bridges, and for ten years a larger expenditure of money will be derived from the sale of bonds for the state and county systems.

I cannot allow this opportunity to go by without calling your attention to the fact that the County Superintendent of Monroe county, Mr. J. Y. McClintock, together with a representative of the State Highway Commission, Mr. Ira P. Cribb, has prepared a report showing the condition of the highways within Monroe county, the county in which Rochester is situated. These reports are for free distribution. You can take one home with you, or, if you will write Mr. McClintock, whose address is Court House, Rochester, you will be furnished with a copy, and so enabled to understand the conditions in this state, particularly in this, Monroe county. And I think the same would apply to the whole state generally. I would call your attention to a few figures embodied in this report. The total number of miles of highway in Monroe county is 1,367.68. The total number of miles of highway in this county constructed by the state, as state and county highways, is 200.86 miles of macadam highway or bituminous bonded roads. During the same interim there have been constructed in this county, town macadam roads having a length of 299.75 miles. In other words, 99 miles more of macadam highway have been built under the town system than under the bond issue. Again, in this county during the same interim there were constructed by the towns 464.15 miles of gravel roads, and 2.70 miles of cinder roads, and 256.51 miles of town roads have been standardized as to width, properly shaped and crowned, subdrained with safety ditches, and provided with guard rails. In other words, since 1898, the inauguration of the good roads movement, up to the present time, there have been improved 1,223.97 miles of the whole county mileage of 1,367.68, leaving 143.71 miles

of town highways that have received little care or attention. But you may rest assured that before another year passes in the county of Monroe, under the state and town systems combined, every mile of highway will have been improved either as state, as county, or as town macadam, or as gravel, or else the highways will have been properly shaped and crowned as earth roads. Every mile will have been improved by the end of 1912.

Since the inauguration of the two highway laws passed in 1898, up to the present time, about 3,000 miles of macadam roads, brick pavements, bituminous bonded highways, etc., have been constructed under the bond issue; and from 1898 up to the present we have improved 3,600 miles of town macadam roads in the towns of the state under the town system, outstripping the state system by about 600 miles of macadam surface. At the same time we have constructed in the towns about 8,000 miles of gravel road. You will see, therefore, that we have over 14,000 miles of improved roads under the state, county and town systems in the state of New York, out of a total of 80,000 miles. During 1910-1911, under the town system, between 30,000 and 40,000 miles of road were standardized as to width, 16, 18 and 24 feet, they being the state standard widths of highways. All such standardization means the proper shaping and crowning, straightening of ditch lines, subdrainage, constructing guard rails, etc.

In conclusion I want to make the broad statement that I believe that in the state of New York particularly, and perhaps you will find it so in the other states, the people are beginning to demand a changed policy of highway work. I believe that the time has come in this great state when the main thoroughfares known as state highways, supplemented possibly by the county roads, should be placed directly under the control of the State Highway Commission and the state be held absolutely responsible for every mile of such highways. I believe the local authorities of the towns through which such highways pass should be relieved of all direct responsibility for the maintenance and care of the same, subject, however, to a slight tax for their maintenance.

There is nothing in the statutes of the state of New York which defines the class or kind of road which shall be built. The State Highway Commission should be em-

powered to be the sole arbiter of the kind and class of construction and should be called upon to maintain and care for such roads and to keep them in a condition to satisfy the traffic demands. There are 100 miles of public highway in the state of New York which have been torn up, and reconstructed in an expensive manner in locations where the soil conditions were good. They were given a condition of soil which needed only to have been provided with proper drainage, and all necessary improvement could have been made at a very trifling cost. I can point to County Superintendent Bashford's county where he can show you a town highway which was torn up and reconstructed at a cost of something over $12,000 per mile when the old town road was sufficiently good to take care of the traffic needs of that community. It strikes me that it is high time that we let a little more good solid horse sense into this question of highway improvement rather than so much engineering skill! (Applause.)

I want to call attention to another fact. In my judgment, if you will take the system of public highways in New York state, you will find that they are loaded with 10 per cent., in some cases even more, for engineering expenses. I will give you my idea and am willing to stand for such criticism as you may give me. From 65 to 85 per cent. of the public highways of this state are, generally speaking, on easy grade and alignment, and such roads on such easy grade and alignment could—mind you, I do not say should, but could—be constructed under the care of a man with an experienced eye without the use of a level. Of course it naturally follows that on the remaining 15 per cent., 25 per cent. or 35 per cent., not included in the above, where there are heavy cuts or fills involving engineering problems, the services of an engineer are absolutely necessary. The truth of this contention which I maintain has been demonstrated in the construction of roads in this state where the engineer in charge of construction has changed the ditch lines and grades regardless of the fact that plans and specifications were prepared at the division office, fifty or a hundred miles away from the work, and that the same were rechecked at the main office in Albany, one or two hundred miles away.

I want to see more good, hard-fisted common sense enter into this problem of construction of the highways. I want

to see more education of the local authorities as to the proper means of conducting highway work. If the system of roads in this state, as I have outlined it, were to be taken over and placed under the jurisdiction of the state authorities to the extent that county superintendents could direct the town superintendents and the rules and regulations be followed out intelligently, then in many instances throughout the state the highways could be constructed by the use of local material, with local labor and local machinery. We need more education of local authorities in handling local materials and in the placing of foreign material when the same can be had at a limited cost.

I thank you for your time. (Applause.)

PRESIDENT PARKER: We will now take a recess until 2 p. m.

FOURTH SESSION

Wednesday Afternoon, November 15

PRESIDENT PARKER: This meeting is now in order.

The first paper this afternoon will be delivered by Major W. W. Crosby, of Baltimore, Chief Engineer of the Maryland State Roads Commission, who is well known to everybody here. It is unnecessary for me to tell you his history, or to make any statement of the excellent work he has done in the state of Maryland, but he has gotten up against certain propositions which he will put before you this afternoon. They will then be discussed, first by some distinguished gentlemen whose names I will give you when the time comes. Major Crosby, Gentlemen. (Applause.)

MAJOR CROSBY: After the very swell introduction of President Parker I feel very much in the position of the man—it is an old story but perhaps some of you have not heard it—the man who was standing on a street corner, quite strapped, and wondering where he was to get his next meal. A boy rushed up to him with a fifty-dollar bill in his hand and said, "Mister, can you change this fifty-dollar bill for me?" He said, "No, I cannot, son, but I am obliged to you for the compliment." President Parker evidently expected me to make more of a speech than I propose to make.

PROBLEMS OF CONSTRUCTION

By MAJOR W. W. CROSBY

Chief Engineer, Maryland State Road Commission

Possibly the problems of organization, administration, planning and recording might easily be considered to be included under the title of this paper. But to attempt to consider properly all these items would require the writing of a book, and even to attempt to touch on all of them in the limited time available for the speaker, would require so hasty a skipping "from crag to crag" as to result in almost entire waste of effort on the part of both the speaker and yourselves. Consequently, the speaker conceives it to be best to confine his remarks to details of actual work, out on the job itself.

Generally speaking, the first operations are those of grading and of installing the underground structures, such as culverts, abutments for bridges and underdrains.

If any clearing or removing of trees and old stumps is to be done it should be done promptly and thoroughly. Where practicable, the removal of trees should be accomplished by cutting off the roots around the tree a little distance away from the trunk and then pulling the tree over so as to rip out the stump proper. The roots thus left in the ground will do no serious harm unless within a foot of the road surface. It is sometimes the practice of the speaker to allow trees to be cut off close to the ground and the stump to remain, provided that there is to be not less than two feet of new fill between the top of the stump and the bottom of the surfacing. It may be trite, but it is at least safe to remark that in no case should a foreign stump be allowed to be placed in any embankment.

Underground structures, especially those that cross the road, should almost always be started as early in the proceedings as practicable. Such procedure not only insures their being out of the way of the later work and gives more opportunity to conveniently handle the public traffic generally to be provided for over a road, but also allows more careful construction and better results in the backfill. Only too often serious defects and extra expenses occur in the surfacing over culverts too recently installed before covering them. In this connection, the speaker will state that it is his practice to use vitrified clay pipe for all culverts

12 ins. to 24 ins. in diameter where the covering over them is not less than 2 ft. in depth and concrete boxes or cast iron pipe where the headroom or cover is less. He has experimented in a very few instances with corrugated wrought iron culvert pipes, but is as yet unconvinced of their general desirability. In his experience, he has had no difficulty with the use of first-class vitrified clay pipe even under heavy fills of, say, 20 ft. or more. Above 24 ins., the speaker prefers what is called "double strength" if clay pipe is to be used, but generally concrete boxes would be cheaper. Of course in the use of clay pipe, care must be exercised in the laying and backfilling, especially to prevent the presence of anything like a stone nearer the pipe than, say, one foot. The speaker has seen a stone about the size of one's two fists forced by the fill above directly through the wall of an 18-in. clay pipe.

The bed on which a pipe culvert is to rest is a consideration frequently slighted. Only too often is it allowed to be of improper or uneven character. This is of especial importance where short length joints of pipe are used. A bed of sand or fine gravel on which to lay the pipe is often desirable and advantageous. Even oyster shells or crusher screenings may be used. The speaker had one case some ten years ago where a road crossed a bight of salt marsh by a pile trestle about 200 ft. long. It was proposed to fill in the space, instead of making the necessary renewal of the old wood work, and to care for a small stream crossing the road through the marsh by means of a double line of 30-in. cast iron pipe. The surface of the marsh was at about mean high tide and the marsh mud of unknown depth. Therefore, along the slight stream depression through the marsh, the speaker laid a bed of oyster shells—the cheapest available mineral material—about 10 ft. longer than the pipe and about 12 ft. in width. The shells were dumped from carts through the floor of the old bridge and spread out as necessary to probably an average depth of 2 ft. and with their upper surface level and just above high tide. The pipe was then laid on the center of this bed and the filling over them placed. The results have been entirely satisfactory.

Especial attention to drainage is necessary in Maryland work owing to both the prevalence of loamy or clayey soils and to the "open" character of the winters. A great deal

of "French drain" is used. The pipe is vitrified clay and generally 4 ins., though sometimes 6 ins., in diameter, with bell and spigot joints. Stone, gravel or shells may be used for backfilling with apparently equal results. We think it preferable to install the underdrain just ahead of the surfacing work in most cases.

Practically all pipe ends should be protected by masonry head walls as a matter of protection and economy, to say nothing of appearance. Generally our masonry is concrete on designs made in our own office. Flat slabs or girders, reinforced when necessary by twisted or corrugated steel rods, are usually sufficient. Occasionally, special circumstances warrant an unusual design. In such a case, bidders are given the opportunity to submit their offers with their own designs. These latter are checked by our office and the comparison made between the offer and the office plans and estimates so that a decision may be had.

Of course, the key to successful bridge work is in a proper foundation and this is a subject by itself. Not much more can be said here than that almost all kinds of foundations have their place and the real problem in each case is one of proper selection.

Preliminary to the placing of the surfacing comes the preparation of the roadway for it, or what is generally known as "subgrading." The speaker considers the matter of a proper subgrade one of the most important of all construction problems and regrets to be obliged to state that it seems to be one too often neglected. In his judgment, more failures in the surfacing have had their rise in defects of the subgrade than in any other source. In fact, the importance of a proper subgrade can hardly be overestimated. A proper subgrade should be firm, even and as little susceptible to damage by water as possible. Gravel, preferably sandy or with no excess of clay, gives an ideal subgrade when properly shaped and rolled. Clean sand will furnish a most satisfactory one, though it may bring about some waste surfacing material. In many localities, neither sand nor gravel is available. Crusher screenings may be substituted with very satisfactory results. Some clays will make a very good subgrade, if not so wet as to be muddy or rubbery, nor so dry as to be dusty, provided the surfacing and underdrainage are so installed as to keep the clay in good condition. Other clays cannot be handled

thus. The speaker has secured satisfactory results in some instances by the use of a layer of gravel, sand or screenings 3 ins. to 6 ins. thick immediately below the surfacing. Also, rolling a layer of stone into the subgrade after shaping it but before applying the first course of the regular surfacing, frequently relieves the defects in the subgrade. Another way is to prepare the subgrade by shaping and rolling as usual and then applying a first course of the macadam of special composition. That is, instead of using for this course, one size of stone, to mix with the ordinary No. 1 stone, say 50 per cent. of sand or screenings (for instance by running the screenings and No. 1 together from the screen). Then spread this mixture on the prepared subgrade, harrow it, and then roll. This has proved a very satisfactory solution in many cases where otherwise the failure of ordinary 8-in. macadam was almost certain. Probably the fine material in the No. 1 stone prevented the coming up of the subgrade material into the macadam and thus its destruction in freezing and thawing wet weather.

In passing, the speaker wishes to state that he considers that this matter of subgrade is only too often neglected in city work where a concrete base is to be used under the surfacing proper. In many cases too much dependence is apparently placed on this concrete base and even unnecessary expense is had for such concrete when by proper attention to the subgrade beneath it, not only better results, but also much saving in cost, might be secured.

In the reconstruction of old roads, it frequently happens that but slight changes of grade are desirable. Many of these old roads, such as the "pikes" have been "stoned" in the past and so massively, but withal so crudely, that they now present to travel surfaces that are solid beds of stone (mostly large) whose unevenness and roughness furnish the main, if not the only, reason for their treatment. Many of the audience will recognize readily a statement from the speaker to the effect that those familiar with such an old road are hostile to any idea of digging into or removing the old roadbed, if only for the purpose of breaking up the large stone. Nevertheless such a procedure is often the economical thing. If it cannot be done for any reason and the old stone bed must be allowed to remain, then the grades for the finished surface must be properly adjusted so as to provide at least a minimum thickness of new sur-

facing on top of the high points of the old stone. And this minimum cannot successfully be less than 4 ins. in the case of water bound macadam. With proper care in bituminous work it can probably be reduced to 2 ins. and possibly in some cases to even less.

Further, in such work on an old road, the depressions to be removed present a problem. It will not do to fill them with an absorbent material like clay or loam, and filling them with surfacing stone may be necessary even if expensive. Frequently, however, a cheaper roadside stone of inferior quality will answer. The same remarks apply to thin layers of material to come between the old roadbed and the bottom of the new surfacing.

In what may seem perhaps to have been a rather cursory way, the speaker has at last reached the problems of surfacing. And here perhaps a breath should be taken in view of the vast outlook.

Are there anything but "problems" in the subject of surfacing? And what a wide field of them, a field yearly becoming wider and more diversified, thanks to the activity of the proverbial American ingenuity, offers itself! To discuss, or even to review, a list of all the problems in this field, would be beyond the bounds of the present conditions, so the speaker will, in closing, merely mention a few salient points under the various kinds of surfacing on which he has convictions, or to which he feels it might be proper to direct your attention.

With sand-clay surfaces, it is important to get an intimate, even, and properly proportioned mixture of the sand and clay. With unscreened gravel surfaces, it is necessary that the gravel be free from stones larger than, say, a goose egg, and from an excess of fine material, i. e., either sand or clay. It must have, however, sufficient "fines" to fill the voids of the gravel stones, and preferably these fines should be of a highly cementitious character. If too weak in cementing qualities naturally, then something such as pitch, must be added to make up for the lack of bond among the round gravel stones and thus to remedy their tendency toward displacement under traffic, especially in very wet or very dry weather.

With screened gravel surfaces, when the correction of the sizing is had by the screens, the same remarks then apply. In some cases, screened gravel may be satisfactorily

"bound" with limestone screenings. With marl surfacing the problem is to secure the necessary uniformity of the material and then to properly compact it in place. Plentiful watering and rolling is important.

With broken stone macadam, in the experience of the speaker, the most necessary, and at the same time, the most difficult thing to obtain is apparently the proper compaction or interlocking of the broken stone. Almost always the rolling of the different courses is less than it should be for the best results, and the deficiencies in rolling are attempted to be made up for by using the screenings too soon and too profusely. Another problem is the securing of the utmost degree of uniformity in the macadam layer as to thickness, evenness and homogeneity—no irregular depths of stone, no irregular thickness of courses, no pockets of material which varies greatly in size, etc.

And with all these surfaces just mentioned, the speaker, at the risk of repeating, must again call attention to the problem of getting proper rolling or compaction.

With bituminous surfaces, the main problem is perhaps again the securing of uniformity; practically all defects may be traced to the lack of it. The use of mechanical appliances of course always helps in securing regularity and homogeneity and generally tends to economy as well. Their desirability is beyond question.

With pavements of various kinds, perhaps a general statement might be made that one important problem is to get them as dense as possible, that is, with sheet pavements, such as asphalt, bitulithic, concrete, etc., the mineral portion must be so proportioned that the voids will be at a minimum and the cement must then fill the voids. The other necessities of homogeneity, or uniformity and compactness also apply. With block pavements, the joints must reach a minimum and then be properly filled. The blocks themselves need uniformity and they must be placed evenly and solidly.

The speaker trusts he may have given an idea of the problems to be encountered in construction, if not a solution for all of them. In solving them, one and all, no factors will count more than carefulness and experienced intelligence.

PRESIDENT PARKER: Gentlemen, it was suggested to me by a member of the directors of this association that

I should stir up something which would create dissension among the members of this body, so that the discussion would have life in it. You all recognize that my duty is to maintain order and not to arouse a disturbance, but I shall welcome any suggestion from any gentleman present, so I hope you will let yourselves out, if you have any inclination to do it.

The next paper in the discussion is to be given by Mr. R. A. Meeker. It is said that but a few good things come out of New Jersey, but there are still some good ones there, notwithstanding that Mr. Meeker is here. He is known to most of you and is a veteran in the art of building roads. Mr. Meeker. (Applause.)

MR. MEEKER, (State Supervisor of Roads of New Jersey): The first thing to be done, even before grading is commenced, is to drive slope and toe stakes marking the outer limits of the cut or fill. This very important task is often neglected in the early stages of the work, and as a result the contractor is subjected to many annoyances and expensive delays. If the cut is commenced at the extreme edge of the slope at the top it is much easier to remove the dirt, and the objections of abutting property owners are met and overcome before they have time to reach any serious proportions, thus saving much annoyance, time and money. If the embankment is begun at its extreme width at the bottom, the fill is thoroughly compacted by the wheels of the wagons and it will withstand the action of water much better. How often have we seen yards and yards of dirt washed out on to the adjoining flats after a rain! This means a loss to the contractor and damage to the work, both of which may be avoided if the outer limits of the slopes of the embankment are carefully marked and the work begun at these lines.

Stumps should never be left in an embankment, as Major Crosby truly says, but in low, swampy ground where they are constantly under water, stumps form a good base for the fill.

I most heartily second Major Crosby's statement that all underground structures should be started as early as practicable and the fills over them made and allowed as much time as possible to settle before the pavement is laid. We have all seen, over new culverts, humps which in time change to hollows spoiling what is otherwise a good road.

With us the vitrified clay pipe culvert has almost entirely given way to the concrete culvert because the latter is stronger and more durable. Our experience with corrugated wrought iron pipe agrees with that of Major Crosby.

Drainage requires great attention everywhere in New Jersey because even in sandy soil we find occasional clay pockets that must be drained in order to draw the water from the soil as quickly as possible. We use unglazed, porous tile, 4 ins. or 6 ins. in diameter, with open joints, and backfill with some pervious material such as cinders, gravel, crushed stone or oyster shells when we can get them. By this means our underdrains work throughout every inch of their length. Underdrains should be installed as soon as the rough grading is done, or much time and money will be wasted. If the subgrade is thoroughly underdrained no other preparation is required except in very sandy soil, where we sometimes use a layer of slabs, 2½-in. stone or brickbats, our aim being to use material of as nearly uniform size as possible. In very wet soil we sometimes use telford, our whole aim in every case being to secure a thoroughly drained earth foundation for our pavement, for, as Major Crosby says, even concrete is valueless on a wet foundation. It makes no difference whether your surface consists of granite blocks, bricks or crushed stone, it will give way if the soil beneath it is not well drained.

The breaking up of an old stone road is one of the pieces of work that provokes more hostile criticism in the neighborhood than anything a road builder can do, but it must be done if we wish to obtain good results, for even two inches of sheet asphalt will disintegrate if laid on Belgian block, and more quickly still if laid over an old flag crosswalk.

In the reconstruction of old roads it frequently happens that g[illegible] changes in grade are necessary to meet the requir[illegible] of modern [illegible] and unless these are made the [illegible] of reconst[illegible] not warranted. For exam[illegible]e stretch [illegible] road lies over a low, flat, po[illegible]ned plain [illegible]t over a steep, stony hill, th[illegible]hat a tea[illegible] the mud of the flat [illegible]ul up th[illegible] steep hill. On the [illegible]nd, on a [illegible] hard surface, the [illegible]am can [illegible]es as much on

the level as it can up the hill. If the driver has to throw off half of his load after traveling two-thirds of his way, and then, after reaching his destination, must return and pick it up, much of the value of the improvement is lost. Therefore, we should say, if you don't do anything else, grade, cut down the hills and fill up the hollows. This maxim is so old that it is new. Nearly 2,700 years ago Isaiah said, "Every valley shall be exalted and every mountain and hill brought low, and the crooked shall be made straight and the rough places plain." Who today can give a better description of an ideal improved road?

After the road is graded and drained the surfacing must be applied. What this shall be depends upon the class of traffic and upon the material that can be most cheaply obtained. In New Jersey trap rock is the hardest and toughest stone that we have and is adapted to heavy travel. Dolomite ranks next in the scale of hardness and is excellent for lighter travel, but both become dusty in dry weather; hence bituminous binders have been used. When the bitumen has been mixed with the stone before it is placed on the road the results, thus far, have been good. But when it has been applied to the material after it is deposited on the road, the results have been lacking in uniformity. We supposed at first that this was due to an uneven distribution of the liquid, but later investigations have shown us that the failure was due to a lack of homogeneity in the stone surface. Where the percentage of voids was low the bitumen remained on or near the surface; where the structure was more open the bitumen almost disappeared, yet upon analysis each section showed the same quantity of bitumen in a 1-ft. slab three inches thick. From this we deduce that it is necessary to bring the road surface to a uniform density if we wish to obtain good results. My friend, Charles Ross, attains this end by grouting with Portland cement, and his roads speak for themselves. President Parker lets the travel thoroughly consolidate the roads in his commonwealth before he applies the bitumen. Thus the practice of both of these experts agrees with the findings of our tests. We, therefore, must return to our former practice of thoroughly rolling and puddling our roads before we apply any bitumen to their surface if we would obtain satisfactory results from surface application.

In the southern portion of our state we have deposits of clay gravel that make the very finest surface to drive over for nine months in the year, but which soften in the spring. These roads are admirably adapted to automobile traffic, but give way under heavy loads. Considering, however, that their cost is from one-third to one-fourth that of stone roads, they will be used for years to come in the less densely settled sections of New Jersey.

In brief, alignment, grade, drainage and pavement must be carefully studied for each road before one stroke of actual work is done, for if you have not determined exactly what you are going to do on every rod of road you will receive more advice and instruction on what to do and what not to do than upon any other class of public work, and should you perchance make one mistake in either design or execution, your shortcomings will be heralded from end to end of the community. (Applause.)

PRESIDENT PARKER: The last of the set speeches for the afternoon will be by Mr. Charles Ross, Street Commissioner of Newton, Mass. Mr. Ross, whether he deserves it or not, has the reputation of being the best street superintendent in New England. I will not tell you what I think of it. It he does not make good this afternoon it is up to him. (Laughter.)

MR. ROSS: In addressing you this afternoon, gentlemen, I will address you as brother road builders and not as brother highwaymen.

The first thing I want to speak about is the location of the road. That is something that should be carefully studied and is the first principle to be taken into account. We have all seen roads located over one very sharp grade, but where you might travel for miles and not encounter another except in one or two places. In many cases it would have been as easy to go around as to go over, and the work of teams is limited to the amount which can be hauled on the one or two heavy grades. A road built with grades of not more than four or five per cent. is much easier for traffic. I still love a horse, although the automobile is faster, and I think we still have to built roads for horses.

In building a road the first thing which should be studied, as has been told you before, is the question of drainage. That is the principal thing. I think Mr. Lyon

said this morning that he would rather have a good dirt road on a well drained foundation than to have a macadam road on a poorly drained foundation. There is nothing like taking care of the water, and it is a very easy matter to put in drains.

Our city is five miles from Boston and we have 175 miles of street. The surface water is taken into the natural water courses by way of drains and catch-basins. I should advise that, as far as possible, all sewer, gas and water pipes be laid, and all connections be made before the street is surfaced. This would obviate the necessity of opening the street for every pipe connection made. The surfaces of many of the streets have been ruined by the continuous openings made by the different corporations for laying conduits, water, sewer and gas pipes and telephone wires. Each corporation promises to resurface the street and leave it as good as before, but we know that this is impossible.

I recommend that corporations obtaining locations should not be allowed to replace the surface of the street. They could backfill up to within six or eight inches of the surface and be required to bear the expense of having the street surface relaid by the city. In this way you can maintain good surfaces on your streets; otherwise it will be impossible to do so.

Now as to the different kinds of material that we can use for street surfaces: The conditions should be changed for the suburban city. I do not think I shall touch on wood block or any other kind of permanent paving, as we have very little in our city. What we have is almost wholly macadam surfaces, treated with the different bituminous preparations. The old fashioned water bound macadam was formerly considered one of the best streets that could be built, but in the last five or six years conditions have changed. We now have the automobile to contend with, and from six months' to a year's automobile travel will destroy the best water bound macadam road. Using any of the bituminous methods on the market the expense of putting on the surface would be but a few cents per square yard more than it would be to put on the old water bound surface.

In building the state highways across the country it is almost impossible to get water. You have to set up an engine and pump to obtain water for the macadam. You

have to roll it thoroughly to make a good water bound street, and after it is built you put on the 2-in. stone, and then the oil or the Tarvia, or any of the bituminous preparations, about three-quarters of a gallon to the square yard. You can put on a preparation, and it penetrates and does not fill the voids, but coats every stone. Then you put on the stone screenings, three-quarter inch in size, roll it again, then apply a second coat of the bituminous mixture, say one-quarter of a gallon to the square yard, for a finishing coat.

You have a surface that is waterproof. If the street surface is kept clean you can cross the street at any point, thus doing away with the necessity of crossings. The streets should be swept as often as necessary. In some sections of the city section men are employed gathering up the refuse; in other places horse sweepers are used. I think the surface of a street properly cared for will last much longer if kept clean.

By paying careful attention to these things the road is kept in order and lasts much longer. Fill all the little depressions as fast as they appear on the surface of the road. Any road in time will show breaks in the surface in places. If the spot is leveled the danger is removed, but if it is not leveled and an automobile comes along at a high rate of speed and strikes the depression, the automobile gets a jolt and it is surprising what damage this causes to the road, besides being dangerous to the occupant of the automobile.

In patching streets we take a preparation of Tarvia, Texas asphalt or a heavy asphaltic oil, about 65 per cent., and mix it with a fine material, either crushed stone or screened gravel, about ¼-in. in size, putting in one gallon of the mixture to a cubic foot of sand or coarse screened gravel. The stone, sand or gravel should be heated before the mixture is applied. By filling the depressions on a rainy day the bad places are easily located, and the mixture applied. We have patched many miles of streets in this way. This constant care of your roads, keeping them clean and patching them is what you will find most needed.

Regarding the building of state roads, I know Mr. Parker has been on the State Highway Commission and that he will agree with me. If you strike a curve and try to turn out on a state road 15 or 18 feet wide, with a macadam sur-

face covered with any of these bituminous materials, especially down on the Cape, where it is all sand, your wheel gets off the hard surface and into the sand, and you are headed for a board fence or a telegraph pole. This is often the cause of accidents. Every road should be broad enough to permit a team to turn out without danger of dropping into the sand at the side of the roadway. A little careful study of the necessity for making the surface a little wider in the beginning is something that will cost a little more at the start, but that will pay in the end.

It is advisable for us to get some idea of the number of miles of road we can build with the money we are to get. The state should not get an extravagant idea that it costs $10,000 or $15,000 a mile to build roads. It does not. In our Berkshire hills you strike the hardest kind of digging. Down on Cape Cod, however, you can make an elegant sand road, as Mr. Parker told you the other day, at less than one-half the expense. So it is impossible to have a hard and fast rule as to what shall constitute your road in every instance. That is where these discussions, conventions and conferences of road builders are useful to us, in bringing out points that will be of benefit to the whole country. I will not take any further time now, but if any of you wish to ask me any questions I shall be glad to answer them if I can.

MATTHEW McEVOY (County Superintendent, Yates County, N. Y.): I would like to ask the thickness of your macadam when completed.

MR. ROSS: That varies very much. It depends on what kind of a foundation we have underneath. If we have a soft foundation, that is a yielding one, we would probably put on from six to eight inches of stone. With a good, hard gravel, three inches is just as good as more, and some of our best streets have traffic of ten or twelve tons going over them in loads every day with only three inches of macadam on the road.

MR. McEVOY: Do you use field stone in any instance?

MR. ROSS: Yes, sir. I think the day has gone by when we must have trap rock only. Now we use almost any stone that is available. I do not say that we prefer it to trap rock, but we have in our city both trap rock and a soft conglomerate stone, a very soft stone. We have a natural water washed gravel, full of cobbles from the size

of your head down to the size of a hen's egg. Since we have adopted the use of bituminous materials we find they adhere to the soft stone as well as to hard stone, and that the wear comes on the bituminous material and not on the stone, so that it is not necessary to use trap rock. You can use any stone, granite, cobblestone, limestone or any kind of stone if you use bituminous materials with them. We take the gravel right from the gravel bank, and run it through the crusher. We have a portable crusher for this purpose, size 12 by 20, which crushes and screens the material into four different sizes. This is the cheapest way to obtain the screened material. The stone is not more than two inches in size. In building, we put on the 2-in. stone, then the 1½-in. stone, and then the bituminous material on top, at the rate of about three-quarters of a gallon to the square yard—not over a gallon. If you put on too much your road will be wavy. We use a light coating, one-eighth of a gallon to the square yard, and the fine screened stone or gravel for a top coat. This should not be over one-quarter of an inch in thickness, and does not cost more than the usual water bound macadam.

MR. O'BRIEN: You spoke, Mr. Ross, about patching, and said that you preferred to have it done in wet weather. Will it adhere in wet weather as in dry weather?

MR. ROSS: Yes, sir; the tar, or any of these bituminous materials, is mixed at the pit and a store pile kept there, and we take that material in rainy weather and throw it right into the water in these small pools. It adheres as soon as the water dries out and adheres readily to the foundation.

G. HENRY ROBERTS (Superintendent of Public Works, Elmira, N. Y.): I am following the same plan with regard to filling depressions. The Chemung river flows through our city, and I have a number of macadam roads made with broken stone provided by the inmates of the jail. In our river, however, I could set up a screen like a coal screen, screen off the rough stones and get little stones about the size of a pea, and from that up to the size of a hickory nut or even to walnut size. Now, putting this material on the road and rolling it, it will not look as firm as other kinds of gravel. From your talk I expect that I could macadamize the road by using the larger material and then putting on screenings for the small material. Am I right in thinking that I can do that?

MR. ROSS: You are right.

MR. ROBERTS: If this plan would work it would be much cheaper for our city.

MR. ROSS: You do not need to run the gravel through a crusher unless you want to get it below two inches in size. We screen a lot of it by hand. We have from 150 to 200 yards of material piled up that way in a yard. We have tar and asphaltic oil and we mix it in this way: We have a two-horse load of sand, which is about 52 cubic feet, and we use a barrel of oil with that amount of sand, which makes about a gallon to every cubic foot of sand. The sand is heated on sand heaters built for the purpose. When the sand is hot the oil is mixed with it. It is not necessary to mix it by hand; it can be run through a revolving mixer. We heat the sand and pour the oil on it and then dump it into a mixer, and then put it in the store pile ready for use. It does not deteriorate if it is mixed in the fall or during the winter.

MR. ROBERTS: I have been interested in hearing this talk about the streets, and it has been a new thing in the city of Elmira. We have one street that is called a gravel street. They were building an expensive dike in the city and had to draw heavy loads over this street. Before they drew them I filled the depressions in the road with gravel and rolled it down. It has had a coating of oil, and it has passed through all of the rainy weather and the heavy traffic and it is one of the best streets in the city today.

We have another street that is practically a clay street. Next year I expect to put it in shape and roll it. It is what you might call a clay road. What effect would the oil have on such a street as that?

MR. ROSS: How much frost do you get in the winter time?

MR. ROBERTS: It freezes pretty deeply.

MR. ROSS: Then I would use oil and not tar. Tar begins to heave and break and go to pieces if you have a great deal of frost. The road oils—any of them—will be good for the work. They are all right. When the ground heaves and the frost is breaking out, the tar breaks. We had a road in our city that was of just the same kind that you spoke of at first—not a clay road, but one of soft loam and gravel mixed. In the spring we had from four to six inches of mud on that street. Two years ago it was treated

with asphaltic oil, about sixty-five per cent., spread on the road hot, a little over a quarter of a gallon to the yard. Then we took what the farmers call a brush-harrow made of white birches and drawn by horses so that the brooms did the sweeping and the best material was on the surface of the road. The oil adhered to the fine gravel on the road and made an elegant surface which has been there now for nearly three years.

MR. ROBERTS: I use the road hone, but in such a case as you say, I would not.

MR. McEVOY: What is the cost per mile of fixing a road in that way, Mr. Ross?

MR. ROSS: From three to four cents per square yard. You can figure the expense of resurfacing pretty easily. I have been in the business about twenty-five years and have kept figures every year. In our city, or in almost any city, a good safe figure is ten cents for every inch in thickness that you put on. Two inches of stone will cost twenty cents; six inches will cost sixty cents. This includes spiking up the roadbed and resurfacing. This figure makes a good, safe figure for an approximate estimate to work on. If you take a square yard and put a coating two inches in thickness on the surface it will cost you twenty cents a square yard. That is my experience.

I thank you, gentlemen. (Applause.)

MR. LYON: Mr. President, I desire to correct the impression, or rather to change the impression that entered the mind of our worthy representative from the state of New Jersey—that I had made a statement that an engineer is no good in the construction or building of public highways. Very far from that is my opinion. I did make a statement that from 65 to 85 per cent. of the state highways in the state of New York, both state and county highways, were on easy grades, and that an experienced eye might be sufficient to do all that was necessary for proper alignment.

I did not say that it was not necessary to have engineers to take care of the other fifteen, twenty-five or thirty-five per cent.—especially in reducing grades. I want to correct that impression if that is in anybody's mind.

Another point is one that was advanced this afternoon by the gentleman from Maryland, Major Crosby. I trust the representatives of New York towns will not carry away

the thought that because the commissioner of highways in Maryland permitted the use of tile for culverts, that we would do it in the state of New York. In the state of New York it is absolutely taboo. (Applause.)

The science of road building consists of getting the best results and the greatest number of miles constructed for the least money. Now the question of drainage is the all absorbing problem to start with. The gentleman who preceded me was speaking of putting in tile for drainage, and the point he made was that it is necessary to lay the tile carefully to grade, and then fill in with gravel or broken stone or similar material. I maintain, Mr. President—and my old friend from Canada, Mr. Campbell, will back that up—that a tile properly laid at proper depth, and covered with the very material taken from the ditch, will perform all the necessary functions. A tile drain, therefore, if put in an upper ditch, or both ditches, is for the purpose of intercepting the water and keeping it from under the road. It becomes the waterway and takes the water away. The water seeks its level and it passes out and down to a lower water level. It is taken up by the tile and carried away. I would like to hear from Mr. Buck or Mr. Blair on that.

MR. BLAIR: There are one or two points that I want to make: First, everything that Major Crosby said, I endorse. But there was one thing I would like to have him say that he did not say. In describing the foundation and preparation for any road, if he had just added that that foundation should be made smooth in every case, he would then have supplied what I think he omitted. As to the rest of his statements I heartily agree.

Now, one of the gentlemen who followed in the discussion made a statement to which I take serious exception. It was his suggestion that the use of porous tile added to the efficiency of the drainage. I undertake to say that not a drop of water gets through the pores of the tile; it always goes in through the ends, whether it is vitrified or porous tile, and if his tile is laid right he will get the drainage.

Now, the chief thing in the matter of drainage is that the tile be laid so that it shall take off the water in the quickest possible manner. In many instances all over the country I have seen a longitudinal tile, laid to grade of

the street, and the water drained into the main pipe. And while it does no damage in a warm climate, the moisture will exude and get into the foundation underneath and then the heaving action of the frost in the northern climate will raise that up.

Now, what you have to do is to lay your drains alternately from center to side, for what you want is to keep the roadbed dry. When you do that no injury to the pavement will follow.

I want to allude a moment to the engineering proposition. We need the engineers and we need them badly in all kinds of road and street construction, and I do not want the inference to go out, even from an engineer, that his services end with his plans and specifications. They should extend to the supervision of the work itself, and he should understand it from beginning to end. (Applause.)

Now, just one thought more, and that is this: I think that Major Crosby pretty nearly answered all the questions.

It is not so much that we do not know how to build a road, but it is a thousand times more that we do not do it as we now know how; and that is why roads of almost every character fail in this country. From the King log drag even to bituminous construction, and then to the brick road, they fail because we haven't the disposition and the determination to see that each character of road is built at its best. When that is done, it matters not what character or plan of road we have, whether water bound macadam or brick, the careful construction of that road adds to its value more than fifty per cent.

I know that if the ideas of construction that are well known in this country are adhered to in the matter of the construction of a brick road, the maintenance proposition will never be known to you, Mr. President. And the same thought applies, to a certain extent, to all classes of roads. We must adapt ourselves to local conditions and usages.

PRESIDENT PARKER: Mr. Blair, I think we are all getting pretty interested in the discussion, and I would entertain a motion for prolonging this for one hour, if there is no objection on the part of the house, and the business meeting can be deferred for one hour beyond the period we set, namely, four o'clock.

[It was moved and seconded that the discussion be con-

tinued for one hour and the business meeting be delayed for that time. The motion was put and carried.]

PRESIDENT PARKER: You may proceed now, gentlemen.

MR. OWEN: I did not expect to say anything in regard to this part of the proposition, but I want to remind this gathering that it is a national gathering—that we run from Maine to Washington and from California to Florida, and that the exponents of one principle in one section of the country will fail in utilizing it in another. I remember very well that Mr. Campbell, Mr. McLean's predecessor, made an address in which he laid down three principles: first drainage, second drainage and third drainage. I asked him what he would do in Arizona where they had no rain at all. So, you see, gentlemen, it brings the matter to this very point, that we cannot lay down a fundamental principle of road construction for the whole of this country. What is good in the state of New York and in Florida and Alabama may be a total failure in California and Arizona. We should take a broad view of this whole problem. We can recite our experiences in the different localities, but we do not want to say to the rest: We do so and so, and you should do likewise.

Now, in the details of this question of drainage, I differ a little with Mr. Lyon. The first point to my mind in the drainage of a road, is to get a grade such that water will run off from the surface, and off the subgrade, and you have 90 per cent. of your drainage taken care of.

Now when you find places where you want to have special provisions for drainage, it is time to modify the foregoing principle. These matters must be handled according to the peculiar conditions of such cases. There is no objection to tile drainage, as that is about as efficacious as any. With tile drainage the water comes in at the bottom of the tile and not at the top. The function of tile drainage is to lower the water table, and then when you have done that, you have all the drainage you want.

Now, whether you put stone on top or brush on top, or filling on top, is a matter of expediency. My practice is to put in a foot of stone and a lot of brush, and then I put the filling in. It prevents the tendency of the pipe to clog. If you have loose stone, the old fashioned blind drain is as good as any.

MR. BLAIR: Mr. Owen, with that kind of a drain, I want you to tell me how you will get your water off, because you have already stated, as is true, that the drainage gets in at the bottom, and that there lies the volume of water that is passing off?

MR. OWEN: Yes, sir.

MR. BLAIR: Now, when that water collects, evaporation takes place, and if it is not passed off quickly, that evaporation will pass up into the structure above the drainage, and when it freezes, what is the result? I say that that kind of drainage for a road is not worth anything in a northern climate.

MR. OWEN: As I say, I have built miles and miles of it.

MR. BLAIR: I have been over your roads and I have found cracks in them.

MR. OWEN: I have never had but five places in 150 miles of road that blew up, in ten years. In the first place, evaporation does not enter into the question. You must put your drain below the frost line, then if you find that there are local pockets, you must take care of them. You may have capillary attraction, but there is no evaporation. Get your fall outboard, get your provisions to get your water into your drain, and you will have no trouble.

MR. ROGERS: (Deputy Highway Commissioner of Michigan): I would like to get straightened out a little in regard to the method of applying bituminous top. Mr. Meeker says that he makes a water bound macadam, and tamps it thoroughly before he puts on his bituminous top. Mr. Ross, I understand, puts his on No. 2 stone, but he applies no binder.

PRESIDENT PARKER: Mr. Meeker, will you explain your method?

MR. MEEKER: Mr. Blair may have some kind of tile that is different from ours, but our porous tile admits the passage of water. He may have a different kind of porous tile. But that is the way ours works as I have seen it.

Now, in reference to the bituminous binder. We had a great deal of trouble in the early days through lack of uniformity in the surface, and to overcome that we tried to make the material as homogeneous as possible, and to reduce the percentage of voids, or make them the same in every portion of the road. If you choose to reduce the percentage of voids with bitumen, well and good. We think

it is too expensive, as we have other material for that purpose. I am speaking now of country highways, roads leading out in the country.

Mr. Ross has a different condition and his streets are beautiful. On country roads we cannot go to that expense, and, therefore, we do not use a bituminous binder on two and a half inch stone. You can compact your road with bitumen if you want to, but we do not think it pays.

PRESIDENT PARKER: Have you all you want out of Mr. Meeker?

MR. ROGERS: Yes, sir.

PRESIDENT PARKER: Now, Mr. Ross.

MR. ROSS: I will try to answer any question. I do not know whether the question has been made plain or not.

MR. ROGERS: I understand you apply the bituminous binder before you put any filler on the No. 2 stone?

MR. ROSS: Not in all cases, we employ a mixing method by mixing the bituminous matter with the broken stone. But we use the penetration method largely. We have used both methods.

While I am on my feet I will say something about a point Mr. Meeker touched upon, and that is on the method of applying bituminous material. I know many people get the idea that the hard and the soft places in the road are due to unequal mixture of the preparation that is sold to us. I think that is not always so. It may be so in some cases, but I find if you take the stone and screen it into different sizes, keeping each layer separate, the mixture, when applied, will penetrate evenly; if not, there will be hard and soft places here and there. If you are careful with your stone screening, I do not think you will have that trouble.

Now, there is another reason for many inequalities in the surface of the road. The average road builder formerly took a two-horse load of gravel or stone, dumped it down and then took shovels and leveled it off. There is always a hard core at the center of such places, where it was driven down when dumped. When a wheel goes over these places, there is the hard center, and I have seen roads where I could count every load of material that had been dumped on the road, even one year after the road was built. The material should be dumped on a platform instead of on the ground, unless turned over with shovels. It is spread evenly from the platform. I think that pays whether it is gravel or stone.

Now, as to the question of drainage: We used to use soft tile on a farm for draining land. As I understand Mr. Blair's statement, all the water goes in at the joint, and nothing percolates the pipe?

MR. BLAIR: That is it absolutely.

MR. ROSS: In our city we use a hard brick for sewers and eliminate ground water and we find that a soft brick will take up from 20 to 30 per cent. of water. You can take a soft tile and cement every joint as tightly as possible, and water will go through it. It will not do that with a vitrified brick or a vitrified pipe.

MR. BLAIR: It will fill up all the pores of the brick.

MR. ROSS: Yes, sir; it will go through the brick and drip down.

PRESIDENT PARKER: Any questions anybody would like to ask now?

MR. DINGMAN, (County Engineer, Wayne County, Mich.): I would make a motion, Mr. President, that it is the sense of the congress assembled here that we give an expression of thanks to Mr. Meeker for the appreciation which he gave to the engineering profession.

PRESIDENT PARKER: Is that motion seconded?

(Motion seconded.)

PRESIDENT PARKER: I take it to be a matter which we will refer to the committee on resolutions, as a proposed resolution. (So ordered.)

MR. RUGGLES: Mr. Chairman and Gentlemen:—I would like to speak a moment on this question of bituminous macadam. I think that if we compare this with the methods of laying concrete, we will get some ideas which may be of value. In preparing concrete we find the voids in the stone, and fill them with sand, we also find the voids in the sand and fill these with Portland cement. The mass then gives the strongest results.

Suppose that, if in working with concrete we had a floor or a sidewalk to lay, who would think of putting down the stone and sand and pouring the grout over it and expect to get a good result? Now, how much worse it would be if the stone and sand were 150° below the temperature of the grout? This is not an exaggerated comparison, but is exactly what happens when you pour melted asphalt over cold stone. When the asphalt is melted at 210° and the stone is at 60°, there is 150° difference between the

temperature of the base and that of the binder. Freezing results, and you get no practical penetration.

It occurred to me about two years ago that if asphalt could be pulverized and shipped to the work in bags, it would be possible to heat the stone, mix the pulverized asphalt with it, and get the same results as if the asphalt were heated on the ground.

I do not want to take credit for the idea of pulverized asphalt; Mr. Clifford Richardson had experimented with this before it occurred to me. In conjunction with Mr. Richardson, we had a section of road laid in New Jersey. There was one section laid with pulverized asphalt, mixed with hot stone, and another laid with the so-called penetration method. The road laid with the pulverized asphalt and stone is a good road today, although covered over with dirt. And the other could not be distinguished from the old dirt road after the first winter. This was two years ago.

We then laid a section of city street 200 feet long on Bergen Ave., near 149th St., New York, a street that has as much traffic as any street in New York except Broadway. This was laid in the same manner, and it is in perfect condition today.

Anyone driving over the roads today in a touring car must think the authorities have the same idea that the Irishman had, when he gave a note in payment of an indebtedness, and said "Thank God, that bill is paid." A road is entirely worn out now before they begin to repair it.

It was my privilege last year to make a tour through southern Germany, where day after day we went over roads as smooth as a floor. It seems that sections of the road are given out to old incapacitated men who otherwise would be in the poorhouse. With a wheelbarrow and some simple tools, the holes are filled up as fast as they are made and the roads are kept in perfect condition.

There is another point that I notice, and that is that most motors will drive in the center of a road, and form two tracks, one on each side of the center, even though you have signs up asking them not to drive in one track. Most motor drivers will do that, and all cart drivers. In Germany, they put up, about 150 yards apart, barriers like sawhorses that run from the center of the road to the outside, on the right side first, and then on the left, so that every vehicle has to pass the ends of these barriers. After

a few days these are moved about 25 feet away from where they were first placed, and in that way every foot of the road gets equal wear. Now this would be an objecttion in this country from the viewpoint of those who want to run their cars at sixty miles an hour; but you can see that in that way you can get the full wear out of the road.

I thank you. (Applause.)

MR. OWEN: That brings up a point which is pertinent to the whole question of road construction. If the president of a railroad says that he wants his tracks to bear a 120-ton locomotive, and the road supervisor says "This track won't stand it," it seems to me that the president would say in that case, "Make a track to take the travel." That is the principle I want to inculcate in this question. The question of narrow tires, and the question of the winding of traffic around barriers, are things I do not think the American people will stand for. Take Brother Lyon's proposition of limiting the load on a wheel. We have a load of 25 to 30 tons on four wheels sometimes. Why should we stop those people and say: "We have not built this road to suit your particular purpose?" My theory is this: That you build your road to stand your travel. Whether it is automobile or heavy road travel makes no difference. It is the business of the people to build roads, and in building roads they should build roads that will accommodate the travel or traffic over them.

PRESIDENT PARKER: I hope some of you gentlemen have still something left to say. When I look at these upturned faces in the audience, it seems to me that we should get a lot of good suggestions which will be of assistance to us all.

H. G. SHIRLEY, (Roads Engineer, Baltimore County, Md.): All railroads have branch lines and bridges that will not carry their heaviest engines, and there is not a railroad engineer but who knows this. I maintain also that the limit has been reached in the amount of load put on wagons and other hauling equipment, and that there should be some legislation regarding it. You can see a heavy automobile truck, carrying from ten to twelve tons, or a traction engine pulling a number of heavily loaded cars, passing daily over the roads, the wheels of the engines being equipped with sharp cleats so as to enable the engine to draw the load. The weight of the engine and the small

bearing surface of the cleats, along with the tractive force required to draw the load, strains the macadam surface to the utmost, often breaking the bond and finally wearing it into deep ruts.

These conditions have come on the counties and states in the past five years, and many miles of roads, and a number of bridges were built before these conditions existed. Now should these roads be torn up and the bridges destroyed because of this new traffic?

What I desire to especially call your attention to, is this: There are certain months in the year when large loads can be hauled without serious damage to the roads, and there are other months when the load should be limited. In our state, from the last part of February to the first part of May, each year, the earth is frozen at night and thaws during the day. The entire earth is saturated with moisture, and, at times, the fog is so dense you can see but a short distance. The speaker, therefore, believes it is unfair to our county and state not to limit the loads that go over our roads at this season of the year.

I for one would like to see a law passed limiting the loads to a point where the roads can safely bear them. In the engineering profession there are men who can build roads to stand almost any load, but what is to be done with the roads and bridges that have already been built?

The cry is now heard that roads are costing too much, and I maintain that it would be more economical and a wiser policy to build roads that will stand the ordinary heavy traffic at a reasonable cost, than to try and build roads at an exorbitant cost for one special class of traffic, for if there is not some restriction placed on the loads, the roads and bridges built today will not be suitable to carry the loads of tomorrow. (Applause.)

MR. BLAIR: Of course, it is understood by those who build roads that they must cost something. But there is this thing which the American people will demand—and nothing short of it will satisfy them—and that is that the roads must be built for the loads—loads such as are developed en route. The kind of road we must have in the state of Illinois must be a road that we can use, and I undertake to say that if the community and the farmers do not build roads they can use when they need them—that is, at all times, including the time between February and May—then they are back numbers.

In the state of Illinois and the state of Indiana, the roads break up unless you build them properly. And unless you have a road that will stand at all times of the year, you cannot use it satisfactorily. Those are the very months of the year when the farmers demand good roads—from February to May—and they are of no use if they cannot be used when they are needed.

PRESIDENT PARKER: Is there any other gentleman who wants to say something?

MR. HOYER (State Highway Inspector, Rochester, N. Y.): I wish to review some of the remarks made here in reference to making the load according to the road. I have been in the construction division of the department of highways for six years, and am now in the maintenance department. My observation is that a well built 6-in. road of limestone or trap rock will stand any traffic that can be put upon it. But my observation is, also, that nine-tenths of the roads are not well constructed. In the first place, the smaller stone in the bottom course are not swept in thoroughly and rolled properly, and for that reason the top course gives way, and the failure is laid to the traffic. The men who have charge of the construction do not always do their duty. When you build roads according to specifications and do the work properly probably any 6-in. road will, as I have stated, stand any traffic put upon it under ordinary condition of the subgrade.

During the past season I have been examining the roads in Genesee county, and I found I had one road that had worn down to the bottom course of stones. It was so rough that the public drove on the shoulder of the road instead of on the macadam. I treated this road, which is a 16-ft. water bound macadam, with a 65 per cent. asphaltic oil, applied hot, and then covered it with one-third of ¾-in. limestone, which, in turn, I covered with No. 1-A, or dustless screenings. The traffic wore down this covering to a perfect, smooth surface. Soon after finishing this oiling an immense automobile truck came along and I stopped it and said to the driver, "Neighbor, how much load have you on besides the truck?" He said, "Six tons besides the truck." I said, "What does the truck weigh?" He said, "Three tons." That was nine tons. He went over this newly oiled road, and you could not see where he passed.

Now, in regard to resurfacing or oiling, my experience is

there is nothing better than water bound macadam, well rolled and well oiled or water bound macadam resurfaced with oil.

The road just referred to had been worn to the bottom course, and I wish to extend a general invitation to anybody that wants to see this road, to go out and see it, as it is well worth seeing.

There has been an assertion made in this convention that it costs too much money to keep our roads in repair. I agree with that. But why is it so? State roads have been built in the state of New York for the last ten years, but the maintenance department was organized only three years ago, so you see for the first seven years of the life of these roads, there were no repairs made on them. For the past three years we have been getting the roads back into shape. They are not all in shape yet, but we are getting them there. We are coming. I would like you to have seen some of our roads when they were in miserable condition, and then see them now. It takes practical knowledge and experience to get them back into shape. We do not want engineering work on them now, but only practical knowledge.

A DELEGATE: Will you describe in more detail, your method of handling these old roads?

MR. HOYER: Yes, sir. This road is five and a half miles long, and the cost was $3,387.34. Figures down to six and a half cents per square yard. I used $1,856 worth of stone, $467 worth of labor, and $20 worth of incidentals. The oil cost $1,083.34. That covered the five miles and a half, and I will guarantee it will last three years, as the bottom is as good now as it was in the beginning.

I apply the oil hot, keeping steam up in a tank car from early in the morning until I am through for the day. I believe the hot application is better than the cold.

MR. BLAIR: What do you do with the oil to make it penetrate into the road?

MR. HOYER: I swept the road clean of everything, with a horse broom, and in addition used a hand broom if necessary. Then on the sprinkling wagons I used a sheet. That sheet leads from one end to the other and the oil runs on the sheet and spreads out more evenly. Immediately after the oil was put on, I followed it up with the stone and screenings, for which I used a spreader wagon. I covered

the road first with No. 2 stone and afterwards applied screenings, using about twice as much as of the No. 2 stone. We did not use any roller; the traffic wore the road smooth.

MR. BLAIR: Did you make the change from No. 2 to the smaller stone because you found it was better?

MR. HOYER: I found it was too rough, and I found it filled voids better on the coarse stone. But I would advocate the use, where the road is not too rough, of 1-A only. But I believe that a water bound macadam road resurfaced with bituminous oil will be the best kind of a road.

I would like to add that you must be careful to see that your contractors do their work thoroughly, from the bottom up. Drain your road first, put in your bottom stones, and fill your voids thoroughly, as there is where your trouble lies. If you do not fill the voids in the bottom stone the road will not stand—the weather and the traffic will put holes in any road. My idea is to commence at the bottom, and to get a good foundation for a road, so that it will stand up well under the traffic load that is put upon it.

MR. HILL: Gentlemen, I will detain you but a moment I want to take issue with Mr. Hoyer about a water bound macadam road. I think there is a better road than that. If you will be kind enough to get the current number of "Good Roads," on page 245, you will get my idea of what a road should be. ["An Asphaltic Macadam Road at Maryhill, Washington," "Good Roads," Nov. 4, 1911, p. 245.] I presented the state of Washington with ten miles of this road.

Some few years ago your president and myself were in England, and we examined with some care the roads in London and surrounding towns. They had a machine at one of those places which kept the hot tar at 200° F. It moved along probably at the rate of four miles an hour and worked at a pressure of 300 pounds per square inch. The preparation was forced in from 1½ to 2 ins., and one application lasted for a year.

Out in the state of Washington, we run the machine over the road and we use an oil which costs us 6 cents per gal. We cover six square yards with that gallon, so it costs about a cent a yard to fix this road in that way. That works very well, too.

In this article in "Good Roads," this month, you will find the best type of road that I know of described.

There is a road built by our friend Mr. Brodie, of Liverpool, with square blocks, which sustains high class travel very well. All the trucking over these four-inch cubes—and it is very heavy in places—is very satisfactory. I also want to raise a protest against the Belgian block.

MR. BLAIR: How are these Liverpool blocks laid?

MR. HILL: On a concrete base.

MR. BLAIR: What cushion?

MR. HILL: I think it varies from three-quarters of an inch to one inch.

I also agree with our distinguished friend from New York in regard to wooden pavements. In Germany they had these blocks almost as strong as lignum vitae, but they were so hard that that feature became an objection. They are now using wooden blocks of Norway pine, partly creosoted.

Gentlemen, I have detained you a long time with what I had to say, and I will close by simply inviting your attention to the article in "Good Roads." The method is not a patented process; my interest in roads is because I love the cause. I thank you. (Applause.)

MR. DANFORTH, (Rochester): I do not know whether my remarks would be in place at this time or not, Mr. President, but I have listened with much interest to the discussion of drainage, and durability of pavements, and I learned with pleasure from the remarks of the gentleman from New Jersey, that it was the business of the experts to build roads that would sustain heavy loads.

Then I say it is their business to provide grades which will give the least possible wear and tear to the horses and the engines.

MR. BRAYER: I want to say a few words in regard to pavements. My business is that of a contractor, and to my mind the macadam pavements are as far out of date as the canal boat or the stage coach would be in comparison with the railroad. It seems to me that we can build more permanent pavements with a little more money, and obtain better results. Our macadam pavements cost $1.50 per sq. yd., where a permanent pavement would cost only $2.00, and the life of them is about three years. There is not a pavement in this city which has not stood over ten years of wear, and some of them as high as twenty and thirty years. It seems to me to be penny wise and pound foolish

to pay a dollar and a half a yard for a road that will wear out in two or three years, where, by paying two dollars a yard, you can get one that will last twenty years.

PRESIDENT PARKER: Does any one else wish to say anything? If not, I will declare this session closed, and the business meeting of the members of the association which was to take place at four o'clock will now take place. I ask all of you who are members to come a little nearer to the front, so that we will be in closer touch with each other.

ASSOCIATION MEETING

Resolutions

PRESIDENT PARKER: The committee on resolutions is required to report, and a committee will be appointed for the nomination of officers. Those who are to take part in this meeting will please come forward and take the front seats.

This meeting is now declared open. We will hear first the report of the committee on resolutions.

MR. TERRACE: Mr. President, I would like to present this resolution at this time—I will not detain the convention very long.

"Be it Resolved, That this convention regrets the absence of its distinguished ex-President, James H. MacDonald, State Highway Commissioner of Connecticut, and understanding that his absence is occasioned by family affliction, it extends to him heartfelt sympathy in his bereavement and expresses regret that he is not with us.

"Be it Further Resolved, That a copy of this resolution be spread on the minutes, and another copy sent to Commissioner MacDonald."

MR. OWEN: I move the adoption of the resolution, Mr. President.

PRESIDENT PARKER: If there is any objection to the adoption of the resolution as offered, I should like to hear it now. Otherwise we will consider that the matter is closed; and we will give the standing vote on it which Mr. Terrace asked for.

(Rising vote; unanimous.)

The next matter before the association is the report of the committee on resolutions. Mr. Nelson P. Lewis is the chairman of the committee.

MR. LEWIS: Mr. President and Gentlemen: The committee on resolutions to which was referred the resolution offered by Mr. Samuel Hill begs to submit the following report:

"First: We believe that the first paragraph of the resolution should be adopted with slight modification. The adoption of the second and third paragraphs we deem inexpedient in view of the fact that they call for an investigation of departments or bureaus of the federal government, a function which belongs exclusively to the congress or to the chief executive.

"The fourth section would be unnecessary in view of the elimination of paragraphs two and three, although we recommend that its concluding words be added to paragraph 1."

A resolution embodying the recommendation of your committee is herewith submitted for the favorable consideration of the convention:

"Be it resolved by the American Road Builders' Association, that this Association believes that the matter of education in road building is of primary importance, and to that end it hereby appoints a committee of three to be designated by the Chair, whose duty it shall be to lay before the President of the United States, the Congress, the appropriate heads of federal departments, and the chief executive of each state, the recommendations of this association, urging the importance of establishing in the several state universities and technical schools throughout the United States, chairs of highway engineering, to be occupied by men versed in the art of scientific road building: to use all reasonable endeavors to have the intent of this resolution carried into effect in the manner above designated, and to stimulate as far as possible the cause of highway improvement."

PRESIDENT PARKER: What do you say as to this report, gentlemen?

[After considerable discussion as to the expediency of adopting the original resolution submitted by Mr. Hill or the substitute proposed by the committee on resolutions, Mr. Hill withdrew the resolution submitted by him.]

MR. LEWIS: Then I take it, Mr. Chairman, there is no necessity on the part of the committee on resolutions to submit a substitute?

PRESIDENT PARKER: There is not.

MR. LEWIS: The committee submits a resolution expressing the appreciation of the association of the various courtesies shown to it, as follows:

"Be it Resolved, That the Association deeply appreciates the valuable assistance and cooperation of the state, county, town and city officers, who have so substantially contributed to the success of the convention; the gracious hospitality of the citizens of Rochester, both individually and through their various bodies; the courtesies of the press, which has given such generous space to the report of our meetings, and cooperation of the manufacturers whose exhibits have added so materially to the educational value of the convention; to all of whom our sincere thanks are tendered."

PRESIDENT PARKER: What do you wish to do with this resolution, gentlemen?

COLONEL NELSON: I move the adoption of the resolution presented by the committee.

(Motion seconded, stated and unanimously carried.)

MR. LEWIS: Mr. President, the committee submits another resolution:

"Resolved by the American Road Builders' Association, that the officers and directors of the association be requested to extend the greetings and cordial best wishes of this association to the American Association for Highway Improvement, which is about to hold its convention in Richmond, Va., and to express to it the hope that its educational campaign in behalf of better highways may meet with abundant success."

MR. HILL: I move the adoption of that resolution.

(Motion seconded, stated and carried.)

MR. LEWIS: Mr. President, as to the last resolution referred to the committee, we have not had time or opportunity to prepare a formal report. I refer to the resolution offered by the gentleman, expressing our appreciation of the tribute to "The Engineer," made by Mr. Dingman. It is the unanimous feeling of the committee on resolutions, that this is a meeting of road builders; it is not a meeting of engineers or contractors or manufacturers. It is a meeting of the road builders. We want to meet here on terms of perfect equality, and discuss our problems with each

other. And none of us is looking for compliments. The committee recommends that the resolution be not adopted.

PRESIDENT PARKER: Gentlemen, what is your pleasure?

(It was moved, seconded, stated and carried that the recommendation of the committee be adopted.)

Appointment of Nominating Committee

PRESIDENT PARKER: Now, gentlemen, there is another thing you must do before you go, and that is to select a nominating committee to choose nominees for office for the coming year. This committee is to submit the names of candidates to the secretary within three weeks. Now, gentlemen, what is your pleasure?

MR. CONNELL: Are nominations in order, Mr. President?

PRESIDENT PARKER: Yes, sir.

MR. CONNELL: I would like to offer the following names: W. H. Fulweiler, of Philadelphia, Pa.; H. G. Shirley, of Baltimore, Md.; C. W. Ross, of Newton, Mass.; C. H. Moon, of Butts County, Pa., and Prevost Hubbard, of Washington, D. C., as members of the nominating committee.

(Nominations seconded.)

PRESIDENT PARKER: Are there any further nominations?

If there are no other nominees to be presented, and the motion to accept the committee is seconded,—as I understand it was,—I will state the question. It is moved and seconded that the gentlemen named act as members of the nominating committee. As many as are in favor of this choice will indicate by raising their right hand. It appears to be a vote, and I declare that committee appointed.

I think that is all that is to come before this meeting, gentlemen. A motion to adjourn is in order.

(Motion made, seconded, stated and carried, and adjournment taken until Thursday morning at ten o'clock.)

On Wednesday evening at eight o'clock a smoker and entertainment was tendered to the delegates by the citizens of Rochester. It was held in Masonic Temple and was attended by about a thousand.

FIFTH SESSION

Thursday Forenoon, November 16

PRESIDENT PARKER: Gentlemen, this meeting is now in order.

Now, gentlemen, today I take it that one of the most interesting discussions of the entire congress will be held, that is, on the question of the problems which disturb the contractor. That is one of the most essential things we have to deal with in this matter, and Mr. C. A. Crane, Secretary of the General Contractors' Association, is going to give you his point of view. I am perfectly satisfied that it will interest every one of you.

He is to be followed by a formal paper discussing the subject, by Mr. F. E. Ellis, of Melrose, Mass. He is a contractor, and has found that we do our business in too small a way, so had to come over to New York for contracts; and I understand he is making a large amount of money out of your state roads in New York. (Laughter.)

The next formal paper in the discussion will be by Mr. E. F. Van Hoesen, Secretary of the New York Road Builders' Association, and a man whom you all know.

That is all the introduction these gentlemen need, and I will let them speak for themselves. Mr. Crane, Gentlemen. (Applause.)

CONTRACTORS' CRITICISMS OF ROAD CONTRACTS

By C. A. CRANE

Secretary, General Contractors' Association

The deliberations of a convention of road builders ought not to be complete without participation by the contractors, who are, literally, the road builders. Yet it is the exception when the views of a contractor are heard, and the discussions are usually carried on by the engineers and officials who design and authorize the work. It is a mistake that such a condition exists, and in requesting that a paper expressing the contractors' views be presented, your executive committee has shown that there is a growing disposition that cannot fail of good results—the disposition for the man who plans and the man who builds, to get together and resolve upon a mutually agreeable proposition.

Two heads are not always better than one. If they be on the shoulders of two engineers, there is apt to ensue a wrangle over technicalities, and the subject-matter is likely to suffer. But if one head be that of a contractor and the other of an engineer, each equally mindful of his reputation, the result will invariably prove the wisdom of the adage.

There are undoubtedly some minds that would regard with suspicion the suggestions of a contractor relative to work on which he intended to bid, but this attitude is passing away, and among broad gauge engineers the advisability of such consultation is being more and more recognized and the practice adopted. It is unfortunate that there is a more or less prevalent tendency to associate contractors on public work with politics and graft. This paper is not designed as a defense of contractors, nor an apology—they need none. And you men who plan and supervise the work know that, in the main, the contractor gives full value for money received, and that the exceptions are no more frequent in the contracting than in any other business. The exceptions are published broadcast and the impression is created that they are typical of all contractors, regardless of the vast majority of contracts that are satisfactorily completed, often at a loss to the contractor, and accepted without comment.

And these exceptions are not always due to corruption or graft. The unsuccessful contract is often due quite as much to the system adopted for preparing and letting the work as to any fault of the contractor. The contractor's plaint is that while the cost of labor and living, generally, are increasing, contract prices are going lower. And the lower prices are not producing better work. Granted that with the introduction of special machinery to supplant manual labor, the prices should be lower, on the other hand, there has been a more than compensating increase in other elements of the cost. The success of a road is not based solely on its cost—we read that good dirt roads may be constructed for $2,000 per mile. And there may be more profit to a contractor on such a road at that price than in paving a highway with gold brick—not the bunco variety, but 18-karat quality—at a figure that would bankrupt a community.

As the discussion here is to include remarks on the

system of unit price bids and the percentage system of bidding, the contractors' views on the form of proposal under which they are now working in this state may not be amiss.

Since this paper was prepared, the old form has been revised, and some objectionable features which are here criticised have been eliminated, largely due to the efforts of the Association of Road Contractors in this state.

In its anxiety to secure a low price and encourage competition, the New York Highway Commission adopted a system for letting its road work, which was calculated to attract inexperienced and irresponsible bidders and to repel those who had made such work their life business, and who realized the futility of competing on such a basis. There is a great deal of truth in the saying, "A little knowledge is a dangerous thing," and it was exemplified in this form of proposal which furnished to the intending bidders the estimated cost of each item of work entering into the contract. These costs are necessarily based on former work, and more often than not are applied to new work in very different localities and under totally different conditions. They supply that little knowledge which may be dangerous to the success of the undertaking, in presenting what appears to be sufficient data to a class of bidders who otherwise would not know how to figure an estimate. With all due deference to engineers, until they become contractors themselves, or work for a contractor, it is a rare exception to find one who has any real knowledge of cost. In determining the amount of appropriation necessary for a piece of work, the engineer must undeniably be governed by past performance, but if he be shrewd he will also consult with his contractor friends on the important items. Having decided upon a sufficient figure to cover the contract work and administration expenses, the appropriation is made to meet that amount, and itemized costs can have no interest for the public which is concerned only in the performance, or for contractors who have, or ought to have, more knowledge on that subject than the engineer.

Such information, however, tends to careless figuring even on the part of otherwise careful contractors. The contractor may calculate closely on the important items and accept the engineer's price on such items as appear

to have but an incidental place in the work. If, subsequently, the quantities of these items are increased, and the price were insufficient, the contractor is apt to feel that the engineer misled him, and to seek an opportunity to take it out on some part of the work, which perhaps can least afford it. If he had prepared his own figures, he could blame no one but himself.

The adoption of this practice of inserting in the proposal an itemized estimate of cost, together with the provision that any bid which deviates more than 15 per cent. from such estimate may be informal, is a scheme to prevent unbalanced bidding. Full and complete information as to quantities and conditions—no more—is all a good contractor requires to make up his figure. If these be accurately determined, there need be no fear of an unbalanced bid. There are only two reasons for the unbalanced bid, collusion with the engineer or lack of faith in his judgment of quantities and conditions. If the first situation exists, no known form of proposal can prevent fraud, but happily such occurrences are rare in the engineering profession. The second situation, though, is a common one. A contractor may have knowledge of certain conditions unknown to the engineer or to his competitors, and the courts have held that he has the right to benefit by such knowledge, even though his bid were unbalanced with the intent to profit by the mistake of the engineer. He may conclude that certain materials specified will not be required or that others will be required in larger quantity than estimated. In all this he is merely putting his judgment against the engineer's, and any restriction on the exercise of such judgment is not meting full justice to the contractor.

The clause providing that, if any bid price varies more than 15 per cent. from the engineer's estimate, the proposal may be deemed informal, is tantamount to a confession of fear on the engineer's part that his quantities are not correct and he wishes to avoid the consequences of an unbalanced bid. Yet this same proposal calls specific attention to the clause in the contract which debars a contractor from pleading misunderstanding or deception because of estimates of quantities, character, location or other conditions. The contract clause alluded to provides that the contractor agrees that his information was

secured by personal investigation and research and not from the estimates of the state commission. Is not this an absurdity? Is there a man present who believes that in the short interval between advertising and opening bids, a contractor can accomplish work which the engineers were months in preparing? Such a clause is designed more for the protection of incompetent preparation than in the taxpayers' interests.

A suggestion was made some time ago in a discussion by Mr. George C. Warren, of Boston, on unbalanced bids and estimated quantities, to the effect that if any item in the contract exceeded the estimated quantity by more than 20 per cent., the excess should be done at the cost of labor and material, plus 15 per cent., regardless of the bid price for the item. Mr. Warren expressed the opinion that if it were understood by the engineer that any increase over 20 per cent. would be regarded as incompetence, and constitute grounds for removal, the intentional unbalancing of bids and estimates would materially decrease, and engineers would exercise more care in preparing their estimates.

In an action brought by a contractor in Connecticut, involving a similar clause in the contract, the court ruled in favor of the contractor, and the opinion stated that "the facts represented in the proposal were such as not to be equally available for both parties; they involved investigations for which expert technical knowledge was required; they were made by a party in a position to have and who assumed to have not only a superior knowledge but a knowledge based on expert examination and study, and they were made for the purpose of being acted upon and promptly acted upon." In justice to the contractor, the state should assume responsibility for its estimates, or at least provide for some equitable arrangement by which a contractor is not saddled with it.

The present form of proposal contains this clause, which is distinctly unfair:

"The Commission expressly reserves the right to change the plans or specifications during the progress of the work, which may result in an increase or decrease of quantities, in which case such additions or reductions will be paid for at the item prices in such proposal."

This clause seems to apply particularly to a decrease of quantities, since another paragraph further along in the proposal reads thus:

"Wherever an increase of quantity from the approximate estimate, whether called for by a change in the plans and specifications or due to more accurate measurement, occurs, then such excess must be agreed upon in writing, as provided in chapter 30 of the laws of 1909."

Provisions should be made that if any change materially affected the cost of the work, such change could only be effected by written agreement between both parties. As it reads now, a contractor would have no right to recovery for materials purchased for the work, if the state should decide on a change which obviated the use of such materials.

There appears to be some ambiguity not only in the two paragraphs just cited, but in another which provides that no allowance will be made for any work or material beyond the lines shown on the plans or fixed by the commission, when read with the specifications which provide in several instances that certain work shall be done or materials furnished, "where shown on the plan, or where ordered by the engineer." Under the section of the highway law referred to as chapter 30, laws of 1909, anything not on the plan must be contracted for in writing with the state commission, and the engineer has no authority to order any work not shown on the plan, nor would the contractor be legally entitled to recovery for such work, since it was performed contrary to the statute. Many a contractor has learned this too late, often after the expense of a lawsuit, and there can be no justification for leaving so misleading a provision in the specifications.

Contractors are not generally versed in the legal aspects of their contracts—they are concerned with the execution, and they look to the engineer for directions. As a rule, the engineers themselves are woefully ignorant of the laws and ordinances which regulate their operations, and they often arrogate to themselves power, and issue orders which may be perfectly good from an engineering standpoint, but which are directly contrary to the law on which the contract is based. The contractor is the man who suffers, and, for this reason, the contracts and specifications should be drawn in a more comprehensive and less ambiguous man-

ner, as much for the guidance of the engineer in the field as for the contractor.

Legislative enactments must naturally have great bearing on contracts and in this state the contractors are face to face with two mandates of the labor law, which affect their work, be it road or any other construction.

First, the employment of any laborer unless he be a citizen of the United States is absolutely prohibited, the penalty for violation being twofold, fine or imprisonment, or both, as provided in the penal code, coupled with forfeiture of contract and all moneys earned thereunder as provided in both the labor law and the penal code. This question is now being argued to a final settlement in the courts, and since arriving in Rochester, I have learned that the county court in Orleans county has refused to sustain the demurrer to the indictment entered on behalf of a contractor on the Barge Canal, who has been indicted for employing alien labor. The highest courts must pass upon this question before contractors can safely go ahead with their work, for if it be a valid prohibition, public work must cease in this state, as there is not enough citizen labor available to do the work required.

Second, the contractor must pay the prevailing rate of wages or suffer the penalty of forfeiture of contract, and what determines the prevailing rate of wages is a conundrum that even the state labor commissioner has not yet been able to decide. Is it the rate paid to the majority in a locality at the time a contract begins? Or, does it fluctuate as demand and supply fluctuate? And is a man a violator who continues to pay the same rate after other and perhaps larger contracts are let in his vicinity, which employ the same class of labor at higher pay? This is a perplexing question, which the legislature should settle, and not leave for the determination of the courts after expensive litigation.

It has been stated in many discussions similar to this that legislation does not promote honesty but is rather for the purpose of punishing dishonesty when detected. I believe that engineers and public officials will agree with me that if their hands were not so tied by the statutes in their relations with contractors, they would be able to secure more satisfactory performance.

Treat a man fairly and nine times out of ten he will

not try to take unfair advantage himself, but it is inherent in human nature for a man to attempt to beat a game which is evidently framed up to beat him, and instead of recognizing that the contracting business today is predominated by men of intelligence and practical training, the majority of contracts prepared by the state and its municipalities would imply that the expected bidders were all rogues or ignoramuses.

It is impossible by such a policy to secure healthy competition. The proposal states that the contract can be awarded only to the lowest responsible bidder. Responsible for what? If he refuses to execute the contract after it is awarded, he is responsible for the amount of his deposit. If he fails to complete the work, his bondsman is responsible for its completion. Every bidder from the highest to the lowest is responsible to that extent and no more—therefore, why not say the contract shall be awarded to the lowest bidder, and be done with it.

It is true, the proposal also states that the bidder, if requested to do so, must present evidence of his experience, ability, financial standing, etc., but instead of being optional, this should be a mandatory provision, and failure to offer satisfactory evidence of that nature should be absolute ground for rejection.

A contract clause which would permit the commission to select the bid which in its judgment would best secure the efficient performance of the work, coupled with the requirement that the contractor must furnish the evidence of ability just alluded to, would seem to be the better way to award contracts. It has been successfully demonstrated for years by the Croton and Catskill Aqueduct commissions in New York City, and it was only on rare occasions that the lowest bidder was unable to meet the requirements. The adoption of that method succeeded in attracting the best contractors in the country, knowing that they were competing with their equals in skill and that the inexperienced "gambler" was eliminated.

Now one more very essential requisite for successful contract work is competent supervision. It is the bane of a contractor's existence to be "bullyragged" by an inexperienced engineer whose sole knowledge is confined to his technical training and a copy of the specifications. And it is often because of his inexperience that he occu-

pies his position—an experienced man wouldn't take the job at the salary paid. Is it economy to place such men in positions of responsibility? To spend millions on public improvements, and not pay the men who supervise them much more than a contractor pays his timekeeper? The reason for much of the trouble on public work is found in the niggardly policy of employing cheap men to do expert work.

Not alone contracts, but public office as well, should be made more attractive to men of high caliber, and in the long run such a policy would prove more economical than the attempt to secure cheap contract work under cheap supervision. (Applause.)

PRESIDENT PARKER: Gentlemen, I see most of you agree with Mr. Crane's sentiments. He has shown you, I think, he is well able to deal with the subject.

Mr. Ellis will now give you his point of view.

F. E. ELLIS (Melrose, Mass.).—Mr. President: I would like to call the attention of this convention to some of the clauses in the specification upon which Mr. Crane has touched, by making some practical applications of these clauses.

There is a clause in the New York specifications which reads as follows:

"The right is reserved by the State Commission of Highways to make such changes in the plans and specifications as may, from time to time, appear to it to be necessary or desirable, and such changes shall in no wise invalidate this contract."

To illustrate how this clause may cause a loss to the contractor I will cite the following case: The preliminary plans and specifications and the estimate of the quantities for a road showed that upon that road there was a surplus of excavated material, which, according to the contract, the contractor was supposed to dispose of. The contractor in making his estimate upon the work found that he could dispose of this surplus material at a profit in filling in some adjacent land. He made a reduction in the price to the state in amount nearly equal to the amount he was to receive for the material which he disposed of. The contract was awarded and after the work had been started the

location of the road or the grades were changed so that there would be no surplus material.

I think the contractors as a rule are perfectly willing to have minor changes made and they expect such changes in a road. But it is unfair to the contractor to make changes, after the contract is awarded, which materially alter the conditions which existed before bids were received. If the last part of this clause were omitted, that is, "and such changes shall in no wise invalidate this contract," the contractor would enter into a contract with a feeling that he would be consulted before any great changes were made in the plans.

I call attention to another matter which appears on the same page in these specifications which shows the lack of confidence the specification writer has in the contractor. This reads as follows: "The improvement shall be started at the part of the road farthest from the source of supply of broken stone, and the entire work shall be conducted and completed under the supervision and to the satisfaction of the State Commissioner of Highways."

It is customary to start macadam at the farthest end from the source of supply of stone but it is not always necessary or desirable to start the grading at the farthest end, and in some cases it is neither desirable nor economical even to start the broken stone as specified. To construct roads strictly in accordance with these specifications would, in a great many cases, add largely to the expense of the road without bettering the construction or the results which are desired. I have seen roads on which, in order to start at the farthest end, stone would have to be hauled a very much longer distance than if the road were first graded between the source of supply and the farthest end. This clause also puts the supervising of the work in the hands of the engineer, and, if interpreted literally, would take away many of the rights which a contractor is supposed to have, and make him nothing more than a paymaster.

I will call your attention to two conflicting clauses in regard to excavating. One reads as follows:

"Excavation will include the grading of the roadway, ditches and side slopes the entire length of the highway to conform to the width, lines and grades shown on the plans, or as fixed from time to time by the commission,

also the digging of foundation pits for all structures, the cleaning out of waterways and old culverts, the digging of all necessary outlet ditches, where right of way has been secured and the grading of all highway intersections. Unless such work is ordered by the commission in writing, no allowance will be made for extra excavation beyond or below the widths, lines and grades shown on the plans or as fixed by the commission. All ditches must be dug before any rolling will be allowed."

The next paragraph reads as follows:

"All muck, quicksand, soft clay and spongy material which will not consolidate under the roller shall be removed to a depth to be determined by the engineer and paid for as 'excavation'; and the space thus made shall be filled with sub-base material acceptable to the engineer and paid for as sub-base."

The first paragraph says that no allowance shall be made for excavation beyond or below lines fixed by the Commission or shown on plans. The second paragraph gives the engineer the right to order work done below lines shown on the plans. It is seldom that any work necessary under the latter clause is shown on the plans and work of this kind is necessary from time to time on most all roads. It is ofter necessary to do the work specified in the last paragraph quickly so that other work may progress.

Resident engineers are instructed not to overrun the estimated quantities and in order to do so they take a great many chances on the subgrade by not excavating soft material and filling in with sub-base as called for in the second paragraph. Trying to build a road upon a soft subgrade is very unsatisfactory to the engineer in charge and is also unsatisfactory and expensive to the contractor.

I think a great deal of difficulty could be avoided if the commission had a little more confidence in the engineers, especially the resident engineers, and also a little more confidence in the contractors. If the specifications could be drawn so that when a contractor had finished reading them he would have every confidence in the engineers' judgment and would feel that the engineers were placing some confidence in him and his ability to manage his own work we would have better roads at a much less cost per mile than that for which they are now being constructed. As it is now, the contractor is constantly run-

ning up against clauses in the specifications which if interpreted literally would cause a great loss or a largely increased price for the roads.

I do not like to publicly criticise these specifications thoroughly; in fact, I did not know until very recently that the subject of Mr. Crane's paper was to be the New York state specifications. If I had known in time I might have declined, as I am doing work for the commission and am placed in the position of criticising the work of engineers under whom I am working.

PRESIDENT PARKER: Mr. Ellis wants you gentlemen to think that on account of it being a delicate situation, he did not want to discuss these specifications. As a matter of fact, he was only too anxious to get the opportunity; and I hope that in the discussion which will take place this morning and this afternoon, he will have a chance to say what is in his mind.

Mr. Van Hoesen will now give you his learned discussion.

E. F. VAN HOESEN, (Secretary New York Road Builders' Association): Mr. President and Gentlemen of the Convention: I have listened with a great deal of attention to the paper just presented to you by Mr. Crane, and I have been interested and pleased at the able manner in which he has called some things to our attention—some of the trials and tribulations of the contractor due to the interpretation of the specifications and the inspection given by the man in charge of the work called for by the contract.

As this is "Contractors' Day," and there are a large number of contractors here, many of whom I hope will enter into this discussion, I do not propose to take up much of your time by presenting my views of this subject. I am not here as a defender of the contractor. I think the average New York road contractor needs no defender. I believe he can rest his defense upon the roads he has built in the past few years for the state of New York. There is no doubt that there have been failures in some roads which have been built in this state in the last few years, but if you will carefully investigate the causes of these failures, you will find that in a majority of cases the failure is due more to the man who planned the road—who may have used material not proper to be used there—

and that the failure is due to this fact more than to the fact that the contractor has not given the contract the necessary attention, or that he has been dishonest.

I have been engaged as an engineer for many years on construction work, and much of that work has been done under contract. For the last two years I have looked at it more from the contractor's standpoint; so what I have to say about contracts, specifications and inspection will, I hope, be approached in a fair way, as I have been on both sides of the fence. The perfect specifications in the minds of most contractors and some engineers must still be looked for. I think we have all worked under the voluminous type of specifications, where an attempt has been made to cover each and every item of work which the man who drew up the specifications supposed might be called for on that contract, and afterward it is found that many of the conditions which were assumed are not correct. We have also had that shorter form of specifications, with not so many words in it, in which nearly every sentence or paragraph ends with the words, "or as directed by the engineer"; and I think we must admit that those few words sometimes covered a multitude of sins.

The specifications should be carefully considered and they should be free from ambiguity. There should be no clauses in the specifications which in the opinion of the man who draws them up are never going to be insisted upon. They should contain no unfair clauses or clauses of doubtful legality. Referring to Mr. Crane's paper and Mr. Ellis' discussion, and their contentions that there are in the state specifications covering state highway work several clauses which conflict with each other, makes me think of the inspector I knew many years ago, who had charge of some contract work on which the contractor was an acquaintance of mine. The inspector called the attention of the contractor to a clause in the specification and said, "You want to do your work in accordance with that clause." The contractor turned to the preceding page and showed him a clause which seemed to indicate that the work should be done in an entirely different manner. The inspector said it didn't make any difference to him what the boss thought when he wrote those specifications on that page, for he evidently changed his mind when he got over to the next page.

Contractors do not want such specifications that a man will change his opinion after reading each clause. The clauses should not conflict.

I cannot agree with the suggestion made by Mr. Crane, that it would be well to state that the contract will be awarded to the lowest bidder and to strike out the word "responsible." I believe that "responsible" does not alone mean the ability of a man to secure a certified check and put it in with his proposal. I do not believe it alone means the ability of a contractor to secure a bond for the faithful performance of his work, but I think "responsible" also means that the contractor is responsible when he is weighed up against his past performances as a contractor, and the quality of his work. Therefore I think that word should be left in.

I do not think many contractors would agree that any commission should have the power to select the man best fitted in the opinion of the commission to carry out that particular contract. That may be entirely right on a large piece of work which costs several millions of dollars, and where considerable care can be given to the subject, but in road work, where there are many small contracts, and where there are possibly from twenty to thirty contracts signed up and let in the course of an afternoon, it might mean that a few contractors would be selected, and the work could be parceled out to them.

This would lead to endless complications, and I doubt very much if any commission would like to let work in that way. I think if that part of the specifications is enforced, and instead of saying that the commission may require a contractor to present satisfactory evidence as to his contracting ability, his financial standing, and the amount of plant he possesses, if it said that they shall insist—make it compulsory—so that a man who is asked to do that, will not feel that he is singled out as a doubtful character, they would get a better class of contractors. If that were done, there would be no further effort needed to give this work to the right kind of man.

Referring to the state specification covering road work, it may be true that all men are born gamblers, but I do not think that when it comes to building roads they should be called upon to take chances in the specifications. I do

not propose to go over the specifications and call attention to the clauses which might be called "gambles."

But there is one matter which I wish to take up, and that is the stone question. Where local stone is specified, the contractor is told where that stone can be obtained, where the ledge or quarry is situated. The department has already taken samples from that quarry and ledge, they have been tested, and the contractor has been told that the stone is satisfactory. In the present specifications it reads, "It shall be satisfactory to the chief engineer." Now, after the contractor gets to work and erects his crusher, and starts in good faith to crush that stone, which, in his opinion, is all right, it is quite possible that in a few days the same official who approved the stone will say that he is not satisfied with the stone—that the supply is not satisfactory. Then the contractor must go and get a new source of stone supply, as the specifications state: "All stone is to be approved by the chief engineer before being used. If after trial it is found that partially developed quarries, ledges or other sources of supply do not furnish a uniform product, or if for any reason the product from any source at any time proves to be unsatisfactory to the chief engineer, he may decline to continue its use, and may require the development of other quarries, or the Commission may require the contractor to furnish other sources of supply; and the contractor will have no claim for increased payment on account of such requirement."

Under that clause, it would seem, if there were no suitable stone in the locality, that the contractor must go out and bring in imported stone at the same cost as the local stone which he was expecting to use.

Where imported stone is to be used, the contractor can protect himself against loss, as he can require the quarry or the stone company to furnish stone in accordance with the state requirements and specifications. But with a local stone road there is always a gamble on the part of the contractor as to whether he can use that local stone. One contractor I know of, after erecting his stone crusher and preparing to start work, was told that he could not use the stone, and was sent elsewhere to get it. It seems to me that the department has plenty of time between

starting the preparation of plans and the day the contract is let to make a careful investigation of the sources of supply to determine whether there is sufficient stone and whether it is of good quality—in other words, to determine whether there is a good supply. The contractor on the other hand, has about two weeks, during which time he looks over a great many roads, and it would be impossible for him to satisfy himself as to a stone supply, chiefly because of the time of year. The ground is generally covered with snow when the contractor is called upon to present his proposals for roads, and the contractor would get the same results as the state even if he had samples tested, as there is no question or doubt that the tests of the state are correct. But there is a doubt as to whether the supply would run uniformly, and the state should take this chance rather than the contractor.

I agree entirely with Mr. Crane when he says there should be more competent supervision of the roads on the part of the state. I do not mean to say that all, or the greater part, of the inspectors in the employ of the state are not competent. I know that is not true. I know a great many of them, and I know they are men of good judgment, capable of carrying out the contract specifications in a proper way. But we also know there are some who are not in that class, and if the contractor happens to draw that kind of a man on his contract it doesn't make much difference to him if they have the best men in the country on the other roads under contract; as far as he is concerned, they are poor ones. So, a man should not be placed in the hands of incompetent supervision or incompetent men.

It may be difficult to get a sufficient number of competent men to cover all the roads in the state, particularly on separate contracts made in large numbers, as they are. Even if we do not consider the question of salary, it is not always possible to get a good man even though the salary is attractive. The number of experienced road builders in the country is small as compared with experienced engineers in other lines of contract work, and until a man has had that experience which fits him for this work, he is not a proper man to put out on a contract, away from all sources of information except that

which is contained in his head, to tell the contractor that he must do this and he must not do that.

Some contractors who have done work in this state may have had good men to supervise their work; but there are other inspectors who spend the greater part of the time sitting on the top rail of the fence with a set of specifications in their hands, seeing if they cannot find some clause which will require the contractor to do his work in a way different from the way he is doing it and in a more expensive manner. And there are many such men in the employ of the state. I would suggest if it is not possible to get a supply of competent men for each contract that the state should supply another grade of men, that would come between the resident engineer and the man on the road. These men could be selected by a promotion examination in which the man's rating would depend not only on his ability to answer the technical and the practical questions that are put to him, but would depend greatly upon his superior's opinion of his ability, his opinion of him as a man, his opinion of him as an inspector. In such an examination attention should be given to a man's past performances in the department, and to whether or not he is a broad gauged, level headed man. By means of such an examination, the department could secure from its present force a sufficient number of experienced men, and these men could be given a number of roads, the number depending upon their location.

It might be that a road in the Adirondack region might require one man's entire time, and in another section, a man might be able to look over five or six roads. He should look over them every two or three days, or every day, if he can. And it would act as a balance wheel for these inexperienced men who are always on the work to see that the blocks are placed for the proper thickness of stone, etc. Then, if the men on the work made a wrong ruling, the contractor would find it easy to get in touch with the competent man who understands the work thoroughly, and he could get satisfaction.

The division engineers and the resident engineers, men who are selected on account of their knowledge of the work, and on account of their being just such broad gauged, level headed men, as Mr. Crane suggested, are too busy, and have too many other duties to perform to go over these

roads as often as they may desire or like. It is a difficult matter for the contractor to get in touch with the division engineer, or the resident engineer, personally or by telephone, as he may be out of the office. If the contractor writes a letter, he gets an answer after three or four days' delay. In addition to that, the average contractor does not want to be classed as a "kicker," and he shuts his eyes and goes ahead to find at the end of the season that he is out two or three thousand dollars, not because he has made any error in his bid, but owing to the fact that he has been harassed and annoyed by things which a broad gauged, competent man would not subject him to. The average contractor, as I said, does not want to be called a "kicker," and so he does not complain as often as he should.

One contractor told me about a man who was an inspector on his road, requiring certain things. I said, "Why didn't you complain?" He said, "I would not"; but, he said, "If I get another contract and they put that man on it, I will throw up my contract and forfeit my money."

Mr. Crane said he thought there was a disposition on the part of the men engaged in this work, that is, on the part of the man who plans and the man who carries out the work, to get together and agree upon some form of specifications which will be agreeable to both of them. I think that is something to be hoped for.

It makes no difference how competent is the engineer whose duty it is to prepare the specifications, it won't injure the state in any way, nor that engineer's reputation, if he calls in to confer with him some of the practical men, some of the road builders who have been engaged in road work for a number of years. Some of them in this state have been engaged in this class of work for ten years, and when they suggest something that is good, it will harm neither the state nor the engineer to incorporate it in the specifications. And I think that many of the troubles of the contractor would be eliminated if that were done. Some engineers may think that if they do a thing of this kind, they are not as big as they are supposed to be; but I think the big man who fills a place where he writes specifications covering several million dollars of work would do well before he sends out these specifications to ask the experienced road builders what, in their opinion, should be eliminated

from the specifications, or what added to them in order to secure the best possible results.

There are dishonest contractors just as there are dishonest men in other walks of life. We find a few dishonest engineers—only a few—and but very few contractors. I believe that with perfect safety we can pick out in this state a number of road builders to whom it would be entirely safe to hand a contract with the specifications and the plans, put them out, tell them to do the work and take away all supervision. The state would get the only kind of a road that the contractor knows how to build—that is, the best road of that type.

I do not know that this would be a good thing to do, but I believe those men who have been in the road business for a number of years, value their business reputation for honesty and fairness and consider it as much of an asset in conducting their business as they do their contracting plant, or their money in the bank.

As I have said, I am not here to defend the contractor, yet having had considerable to do with the preparation of specifications such as I have been criticising—although I do not believe that I placed any of these bad features in them—I desire to call attention to the fact that all these little things are annoying to the contractor, and prevent him from doing his work as it should be done. They are annoying to the man in charge of the work, as they cause friction between the contractor and himself, and if they could be avoided, you would get a better class of work for the state, and that is something everybody here wishes.

PRESIDENT PARKER: We will now take a recess until two o'clock.

SIXTH SESSION

Thursday Afternoon, November 16

PRESIDENT PARKER: Gentlemen, I think there are enough of us here to go ahead with this meeting. I will advise you that I am to leave tonight, and will surrender the baton of office to Mr. Owen.

I hope you will start in and discuss the questions which have been presented to you from the contractors' point of view and if any engineer or anybody else has an opinion or

a view to express or a question to ask, I hope he will ask it, or state it.

The purpose of these meetings is discussion and the exchange of views, and I think they will be valuable if you only let yourselves out, even though it is harsh criticism as distinguished from praise. I think harsh criticism will be more likely to arouse discussion than unstinted praise. Therefore, I hope the most stringent criticism you can bring to bear will be made upon this question, whether on the contractor or on the engineer or on the superintendent or on the commission. I hope none of you is so shy that you will not be willing to start it.

I would like to say that the meeting tonight in this hall is one that I do not think you or anybody should miss. The stereopticon views and the lectures to be given are of absorbing interest, and I hope all of you will come and bring your friends, so that this place will be filled. It is to be opened at eight o'clock in this hall.

Mr. Owen will start this thing going, but I hope you will all take part.

(James Owen, Third Vice President of the American Road Builders' Association, takes the chair.)

CHAIRMAN OWEN: As this is "Contractors' Day," it is a little presumptive for an engineer to "butt in." The only thing I wish to suggest to the contractors on this road business, as well as contractors on other work, is, whether the future practice will not be for the contractor to have his own engineer. In work of magnitude that practice has become almost universal at present, and the contractor's engineer and the principal's engineer can get together and arrange things, and by that means save an enormous amount of friction, and prevent, in most cases, any possible error.

I bring this out, as I think it is a thing that the road contractors have not taken hold of as they should.

In most of the work that I design now, I provide positively that the contractor shall have his own engineer, that is, he shall have the control of the work and also the control of so much engineering as is necessary for his part of the work, subject to the revision and correction of the engineer.

Now, there is another point I want to bring up, which is more pertinent to the road question, and it is a matter of considerable importance to road contractors in the future.

The construction of the road is but a mere incident in its life. The contractor builds it and he leaves it, and the care or maintenance of it is vested in some other authority, and consequently, in the future, the work of maintenance will be greater than that of construction. My thought about that was much emphasized some years ago by a county engineer from England who was inspecting our roads. He said he had 500 miles of road to take care of in England, but he had only built a couple of miles. In the old sections of New Jersey where we have been building roads for twenty years, the construction department is dwindling, while the maintenance part is becoming enormous.

And then comes the question of how much of this should be done by day's work, and how much by contract. That is a matter which offers considerable difficulty, and I would like some of the contractors here, and gentlemen who have charge of roads in their official capacities, to bring up their experiences before us, as they can throw considerable light on this question.

Will you say something on this, Mr. Bristow, and open the discussion?

FRANK W. BRISTOW, (Superintendent of Repairs, New York State Highway Department; Rochester): It is a rather broad question to decide in regard to maintenance work—whether it should be carried on by your own force or whether it should be done by contract. My experience is that ordinary surfacing work, including minor repairs, can best be done by your own forces. Surface applications of dust layers can be made by either plan, though more satisfactory and economical results are secured by your own forces. Resurfacing or reconstruction is properly work to be done by contract.

CHAIRMAN OWEN: What is the experience of some other members on that point?

MR. COOLEY: I hail from a portion of the country where conditions are different from those in the eastern states. I am from Minnesota. All over that great western country you find roads built on a hit-or-miss, patch-and-patch plan which has been in vogue since the country was first settled. And it presents a difficulty that you people do not have to contend with, as a general rule. We are in favor of doing our work by contract, but only when we can specify precisely what we require. And I think that in

all contracts there should be such an understanding between the party of the first part and the party of the second part, that there would be no question as to exactly what is to be done. If there is any such question, the party of the first part, or the owner, as the case may be, must pay a higher price for his work than if the specifications were drawn precisely. But in the improvement of our highways, of which we have 80,000 miles in the state of Minnesota, we find it impossible to determine exactly what we want, and that has led us into a great deal of trouble with the taxpayers.

In every contract I have let in that state I have prepared for extra work, or work not contemplated at the time the contract was let. As I stated, most of our roads have been built in the neighborhood of fifty years. We built on the hit-or-miss plan, and we did not know whether the foundation of the road would carry the future traffic over it or not. We did not know that, so we were required to insert a clause providing that in case of any unforeseen contingency requiring work not covered in the contract, the contractor should do the extra work under the supervision of the engineer, and receive ten to fifteen per cent. for his work and the use of his plant, over and above his pay-roll; and we required that we be notified so as to put a timekeeper on the job for the state.

We are not here to give advice or instruction, but we are trying to find out all we can. We are building ten or fifteen stretches of macadam road, and before we allow any expenditure for the metaling on top we require that a firm foundation shall be put in. We occasionally find places where the ground springs under the impact of the road roller, showing that in the past some fool of a road overseer has built that road by raising the grade with anything he could get—sods, stumps, roots, etc., and preventing it from becoming a firm foundation for a macadam road. We provide in such cases that the extra work shall be done under the supervision of the engineer, regardless of the contract, and paid for over and above the cost.

We have another difficulty in the way of construction that you do not have, and that is with the material of which we have to construct our roads. We have in our state many hundreds of square miles that are comprised in the drainage districts. This territory is partially covered with water,

and moss and peat four or five feet deep. We have to build roads of the material we have, and of the roads which we must build of that class of material, some will become compact under our drainage system, and be capable of carrying a load and becoming suitable foundations for future improvement.

Now, it is not advisable that the engineer be at odds with the contractor. We realize the fact that the contractor who is making a good, reasonable profit on his contract is the best man to deal with. And we also realize that if we have a contractor who takes a contract at a lower sum than he should, we have to spend more money watching his work. But in order to get a suitable foundation for our system of roads, we have got to provide for all contingencies of uncertainty in the foundation.

We have another condition that calls for interference on the part of the engineer. In many of our marshes you may sound for ten or fifteen feet, and get to what is apparently a solid bottom of hardpan or gravel, but by careful churning you will break through it, and the sounding rod will go down several more feet of its own weight. That is one reason why we have to make this clause in the contract to provide for such contingencies. In Minnesota we have driven piles sixteen or eighteen feet long, which had to be lengthened to eighty or one hundred feet. So I say there should be a certain amount of flexibility in contracts in order to do justice to the contractor and to the engineer. If we do not know precisely what we are to do, we must provide for contingencies.

We have something else to contend with there—that is the eight-hour system. In the legislature a few years ago there was passed an appropriation of $10,000, to be expended under the supervision of the state engineer to build a road at Lake Itasca. I was talking with one of the contractors, and I asked what he paid his men, and he said $1.75 a day. I said, "What are they?" He said, "Italians." "Where is your padrone?" I said. I went to see the padrone, and I said, "How much are you getting for your men?" He told me $1.75. "How much do you work?" I said. He said, "Ten hours." I said to him, "Will you take $1.50 for a day of eight hours?" He said, "No."

The law provides that no man working on public works

shall work more than eight hours. You cannot get ten hours' work a day and pay proportionately for it. If the laborers work over eight hours, the engineer in charge and the highway commissioner are liable for heavy penalties. So we could not get this work done; the county contractors got it and paid $1.75 for ten hours instead of paying the same amount of money for eight hours, as we were doing. The conditions in the middle and far West are more serious than anything you have to contend with in these richer states. You can afford to build roads at $10,000, $15,000 or $20,000 per mile.

We are subjected to difficulties you gentlemen in New York have, too, and we have also occasional difficulty in harmonizing matters between the state and the contractor. I have been obliged to do a whole lot of work by the day, as there was such a howl raised about these uncertainties in the contracts. We tried to build a piece of work outside of Minneapolis, and the contract did not specify exactly what was wanted, because it could not so specify unless we dug up the road in advance. And there we were. We have to meet such conditions, and they make it desirable that there be more harmony between the engineer and the contractor. Engineers do not care to find fault with the contractors all the time—once or twice is enough. But if the contractor has contingencies to meet that he knows nothing about, differences are brought up.

Two years ago I was called on to superintend a contract for two or three miles of road. The lowest bid we got was $11,000; our estimate was $6,000. I went to see the contractor and asked him why he would not make a reasonable bid. He said, "Well, I am afraid of the engineers." They had a copy of what we call the "Red Book," which provides for all the contingencies we could imagine would occur in road contracting work. They got hold of that and they were afraid. Under the heading of "Stone," it said that no stone more than one inch in diameter should remain on the surface after it was finished. We did that work by day labor and got ten hours of labor for $1.75, and we did it for a number of dollars under our estimate. There is no use of being afraid of an engineer if he is fairly honest and intelligent. The engineer is interested in seeing the contractor make a reasonable profit after fulfilling the terms of his contract. So you need not be

afraid of the engineer if you have a contract that properly specifies the work to be done.

CHAIRMAN OWEN: We are obliged to Mr. Cooley for his statement.

Mr. Headley, let us have your views on the contractor's side.

W. T. HEADLEY, (President, Headley Good Roads Co., Philadelphia, Pa.): What is the question, Mr. Chairman?

CHAIRMAN OWEN: The papers this morning were supposed to be written by contractors, and the general trend of the papers was seemingly to somewhat criticise the engineer, not only in his methods, but in his manners and also in the treatment of the subject in the specifications. And while it is "Contractors' Day," the question arises now whether your experience as a contractor will corroborate what Mr. Crane and Mr. Ellis said on the platform. Have you had the same trouble as the others?

MR. HEADLEY: I won't say that. I thought the question was whether repair work should be done by contract, or whether the municipality should do it with its own labor.

My experience is this: If the work is to be done by contract, the public officials let it go too long because their engineer cannot draw a specification that the contractor can follow. They do not fill the little holes until they become big holes. Then they inspect and see the road when it is full of these holes, and they say the condition is awful, and realize that something must be done.

My idea is that the maintenance of a road should be carried on by the municipality or the county or some head organization which can go ahead with the little repairs as they crop up. A contractor cannot take that work unless there is a sufficient amount of it to keep a force busy for a reasonable time. If he can get enough of it, then he can do it only on a percentage basis, as he cannot tell what it will cost. This summer I had a little experience on that line. There were ten or twelve miles of bituminous road which had been down three or four years; in some parts of it there were holes and other imperfections. An estimate for its repair was wanted. I had been interested in the construction, but I could not tell what it would cost to make the necessary repairs. They told me to repair the road on a percentage basis. This I did,

and the cost was about $500 a mile. The road was a heavily traveled road, about 12 ft. wide, which had been down four seasons. If those repairs had been made from time to time they would not have cost as much money. But in this county they have no organization for repair work. It is all done by contract; and they had to let it go until it was big enough to warrant a contractor going there with a force of men.

My opinion is that every county should have an organization for ordinary repair work. When it comes to the larger repairs, the engineer can draw specifications and say: "I want this made in such and such a manner, and so thick." Then contractors can bid on it, and get results. Otherwise, I do not know how it can be done. If it is to be done by a contractor, I say it should be done on a percentage basis.

C. A. KENYON, (President, Indiana Good Roads Association, Indianapolis, Ind.): This is a broad question, gentlemen. I have a feeling of hope for the future, more than for what can be settled just now. I believe that as time goes along, new systems and methods will be devised which will change the present costly ones. I believe we will have big automobile trucks in which we can carry prepared material and hot bitumen, ready to spread, where a repair is to be made, and that repair can then be made in a moment, and they can quickly proceed to the next. I believe that it will be possible for a county with one such single machine to take care of 500 miles of road. A big part of all the present cost of repairs on bituminous roads is the assembling of material and labor. How to get them to the defect in an economical way is the question. But if you have a machine that will take the material and the men and the tools, and do what such a machine can do, with its complete equipment, you have made much for economy. When the repair is made, it is well made, and the men are soon on their way to the next place. Instead of dragging along, they can go at the rate of fifteen miles an hour, and the first thing you know, much work has been done. I believe that a machine can be devised such that 500 miles of road can be taken care of by one machine and its equipment. If you can do that, you can do the work in less time, and much more cheaply than by any other method. Of course the piles of stone you have now along

the road provide a very fair method, but you do not get the best results from it at the lowest cost.

In the west of England they have a way of taking the ordinary macadam road, and by the use of what they call tarred stone, that is, stone mixed with tar, making ordinary repairs. It comes from gas works, and after being left for three weeks with sand piled up over it, is ready for use. The patrolman goes along, taking it in his cart, and places it in the holes in the road. He puts it into the rut or hole cold, and does not tamp it. I said to him, "My idea is that it should be tamped." He said, "No, the traffic will press it down." And sure enough, I saw where the traffic had worn it down, and it was smooth and almost as hard as an asphaltum road. It was three or four years ago that the English road builders found that they had discovered a way to do their work in a much more economical way than they had known before.

Now, when you come to put directions for repairs into a contract, it is, as the last speaker said, a difficult proposition to specify all of the various things. It is a problem that calls for the ingenuity of a fair minded attorney, an engineer, and a contractor, combined.

Most engineers have been so afraid of their reputation, or ignorance, that they wanted to be sure they would not be subjected to criticism in the execution of an improvement contract; and they sought to guard against it by putting all sorts of tight provisions into the specifications to hold the contractor to his contract. Then they can say, if there is any criticism, "Look at the contract." The result is, you do not get what you want. We lay things on contractors that they ought not rightfully to bear. There can be no good service given to the public when the contractor is bound to lose money on the work. You can almost bet the public will get the small end of it in such a case; even with a good engineer and a good inspector, the contractor will find some way to beat the engineer and the inspector. People cannot afford to have their work done by someone contributing out of his own pocket to do the work without getting any compensation for it. And yet, there are some of us who are perfectly willing to do it. In my state, there were a great many people who were, when we had a contract for a state house—a two million-dollar contract it was, and

a great big contractor got the work. It cost him $2,-400,000 to build that state house, and he went into his pocket for the excess and built it, out of pride, and since then he has been on his uppers, and many people in Indiana were glad to think that even though it broke the contractor, they got the state house at the contract price. They accepted $400,000 of his money to carry out their work. But we are reaching a point where the public says: "Give us honest material, honest work and good construction, and we are willing to pay a proper price." I believe it is the sentiment of the engineering public today, and as far as I know the contractors feel as if they would like to do the same thing, to give honest work to the public. (Applause.)

COL. E. A. STEVENS, (Commissioner of Public Roads, New Jersey): The differences between the road building authorities and the contractors are very important elements in road construction. As the last speaker said, a contract which is eminently unfair to the contractor, while it may result in a slight profit gained on that one job, is pretty sure to result in loss to the public that is willing to accept that.

One of the first questions which arises, it would seem to me, is that of proper legal safeguards; but in these days we must be rather careful of that. The best method to insure responsible bidders is the method that prevails in England on Admiralty work, where the names of contractors go on the Admiralty list. I want to ask contractors here, and, if possible, I want to get their views as to the advisability of any such plan.

My short experience in patrolling New Jersey roads has shown me that one of the matters which give rise to considerable trouble in the carrying out of the contract is the quality of material which is to be used. Reference was made to that this morning in the matter of stone, the stone varying in quality, especially in undeveloped quarries. The same is true of our Jersey quarries. If you go down into a gravel pit you will strike sand, which is, of course, unfit for gravel roads. Besides that, the bituminous materials to be used require careful inspection, and should be subject to careful inspection. I think all these materials should be submitted and judged by samples, and should be tested before the bids are opened. I want to submit this to the contractors present and get their views on that subject.

It was pleasant to me to hear that some road departments had time to make the necessary examinations—more time, in fact than the contractors had. My experience is quite the reverse. Our department is so completely overloaded that it is out of the question to expect it to make a thorough examination before a contract is put out. That is a question of restrictions on the department. I think personally—and this I want to submit also to the contractors—that most of the road contracts I have seen, both in New Jersey and other states, are deficient in their engineering features. That is, the plans are not such plans as show clearly a great many details of cost which enter as important items into the total cost of the road.

I want also to put in my expression of approval to the statement of dissent from that usual clause "as directed by the engineer."

There are some places where that clause must go in, but its general use in our road work is a sign of slovenly engineering. I want to add that I am not in this point criticising the engineer. I want to say that my experience shows that the engineer is not given the proper time, the proper facilities nor the proper force for making the examination necessary to draw a clear specification.

There is another point which I want to say a word on, and that is this: My own experience, which has been short, has been that the worst inspector for a contractor to have, is a good-natured fellow who sits by and lets everything pass him. He will cost the contractor more money than any other. I have on my hands today two sections of good road, both built by the same contractor, one of which was laid approximately one year after the other. That second section has been completed and accepted. The first section is not yet accepted. My last inspection, ten days ago, revealed the fact that it was not yet in proper condition. The same conditions prevailed on the two roads and the only difference was the inspector. One inspector was lax and allowed the contractor to do whatever he pleased. There are numerous defective fills in different parts of the road due to the hurry of the foreman who was trying to cover a given number of feet each day, and those defects must now be corrected with large expense to the contractor and with the result that the road will not be as good as if properly built at first.

I favor very strongly the system of having someone besides the inspectors on the job. In New Jersey our inspectors are not engineers, but very often farmers, and sometimes mechanics, generally men of some intelligence and some little experience in the work, but in no sense of the word engineers. These men are having inspections as frequently as possible by men who are skilled and who go over the road as it progresses. It seems to me we will get better results in this way than by turning it over entirely to the engineer, who cannot afford to take the work at the price which the public is willing to pay for inspection. Another thing is that the men you can get for that work are either unskilled or without experience.

MR. ROBERTS, (State Highway Commissioner of Washington): As an engineer of twenty-five years' experience I will plead guilty to the indictment. The speaker who just took his seat, after saying that the clause in the specifications, "and it shall be done according to the approval of the engineer," denotes slovenly engineering, made a just accusation. The man who puts it in a contract is a slovenly engineer. It is to cover his defects, or the defects of investigations. I have been on work for contractors and municipalities and public service corporations, and contractors are all alike the world over and engineers the world over are alike. The engineer is in it to make a reputation, or his salary or to hold his job. The contractor is in it to make a profit, and the minute you cut that profit, he will squeal or shirk his work.

The first specifications I ever wrote were written after I had been engaged as a city engineer in a small western town, and I think I included in every clause those words that were quoted today: "The work shall be done to the satisfaction of the engineer." I did not know better.

The statute covering road work in Washington provides that the work shall be accepted by the State Highway Commissioner, or by the Chief Engineer or some other authorized person; hence inserting such words is but a waste of time and printer's ink. I am glad to say we have intelligent men in the State Highway Department in Washington. One of our men was educated in New York, then he went into railroad work, which is splendid training for road work such as ours, and now he is working with us on bituminous macadam.

The state of Washington, which I represent, is really an unknown land. I dare say that if you were asked what the rainfall is, you would say it is twice what it is at Rochester. That may be true in some places where we have 100 inches of rainfall annually; but we have an area there where we have only seven inches annual rainfall, and that area is as large as the state of Massachusetts. The mileage there would not permit, nor would they want in that section, such expensive roads as have been described.

We have another section, the Olympic area, 150 miles north and south, and 60 east and west. A state road through that district cost $600 to locate, and it was done very reasonably. One of my first undertakings in the department was to investigate a contractor's claim for more work than he had been allowed. He had been paid for grubbing by the square rod. The unit system prevails. He had one price for light clearing and another for heavy clearing. You have seen trunks of trees and slabs of stone that a contractor had to remove, but think of going up to a tree, eight feet in diameter, and 300 feet tall and cutting it down and taking the stump out. One of the foremen of the contractor said, "We consider that one box of powder will loosen it, two will shake it, three will bring it down and four will blow it from the right of way; but powder is cheaper than man labor."

The unit price system is the only fair one between the municipality and the contractor. But do not expect, you engineers who are younger or older than I am, to be able to continue the process of writing specifications without conferring with contractors. The best specifications I ever wrote were made in conjunction with the contractor. I asked: "Does this clause appear fair to you?" Then I went to another and asked him, and he said: "It does." Then I took it to a third one, and said, "Does this appear fair to you?" "Yes," he said. Then I said, "Submit to it, and hold your peace."

The next party to take into your confidence is the attorney—in our state the Attorney General of the state is the man. Washington is a new state, only twenty-two years old, and our law is not crystallized as it is in New York.

Finally, the fourth party is the man who pays the bill,

in our state, the State Highway Board, composed of the Governor, the Auditor, the Treasurer, a member of the Public Service Commission, and the Highway Commissioner. Those five men pass on all contracts, and they must be satisfied. If you omit any one of them you will get into trouble.

It was said this morning, and it is true, that if the engineer is incompetent, there will be a failure; if the contractor is a man of inexperience, there will be a failure. There must be coordination and cooperation. Don't believe that a college education will equip a man to do contract work. For every problem in calculus I have forgotten, I have learned a new lesson from a contractor.

All of this is valuable discussion for all of us, and the object of this convention will be attained if we take these lessons home with us. I hope there are also lawyers and business men and bankers who come here. They pay for what we are indulging in.

I thank you for your attention. (Applause.)

A. J. ROCKWOOD, (Rochester, N. Y.): Mr. Chairman and Gentlemen:—I am not a public speaker. I have been on both sides, however. I have been connected with the improved roads since they started, either as an engineer or as a contractor. I was a little put out when I read in this morning's paper, that owing to a political flip-flop, all the work in this state has been of no value. We built good roads—water bound macadam roads. We had the same experience as in other states and in foreign countries. But the automobile has changed the conditions. I will not talk on the engineering side. The most surprising thing to me is that no one has said a word about the deferred payments to contractors for work which they have already done.

Five years ago, when politics changed, I went on the contractor's side of the game, and some of these things came closer home than before. We started to build roads with specifications covering only four pages of foolscap paper, and we built better roads and made better plans than there are today. The contractor has nothing but figures, he has paid out a lot for bonds that he need not have paid, and he is in trouble with the engineer, as he thinks he has done more work than they measure. He does not know who will accept his work, at the present time, and it usually

takes him longer to get his money than it does to build his road. There are engineers who will tell you that in this past summer I built eight miles of road in less time than they have taken to pay me. The road has been inspected by three different sets of officials, and I have done work that was no part of my contract. I assume there are many contractors, who, like myself, have to discount their notes and pay interest for it, and I think in those cases that the contractor should be paid interest on deferred payments. There are times when the engineer forces on the contractor things not included in the contract. The trouble today is that nothing is shown on the plans. Take such things as fencing, for instance. The engineer wants to save four or five rods of fence, and he won't give you a "bill of materials." If you buy as much material as is called for in the contract, you will have some of it left on your hands. I am one of the smallest road contractors in the state, and I have fifteen carloads of junk.

The trouble with the specifications is that they are too verbose. The engineer does not want to take any responsibility, he wants to have it so that if he gets a contractor who has no pride in his work, he can hold him up.

The trouble with the specifications is they say too much. They contain a lot of stuff that is not expected to be used, and they are put into the hands of young engineers just out of college, with no experience and hence unable to properly interpret the specifications, and one man has it interpreted one way and another five miles away has a different interpretation. The difference in those interpretations is the profit. The engineer has ample time so that he can get out and look up the stone, and he should know what he wants. A little experience I had a few years ago was this: I bought the stone that the engineers said they wanted to use, and I got out 1,500 yards. Then the resident engineer informed me that I could not use it. Fortunately, I had an acceptance of that stone in writing, and I did use it.

I bid on a road last spring under specifications in which the engineer called for that same stone, and after I had built the road, they held me up on my pay for six months because I had insisted on using the stone which they had approved. The engineers who had charge of that road are in the room, and they can tell you the facts. I am unfortunate in expressing my opinions right out loud.

Your specifications are not complete, your plans are worse, and they show nothing, and they are put in the hands of young boys just out of school who think they are hired to "bust the contractor." That is plain language, but it is fact.

I did not realize these things when I was on the other side of the game, but still I was always fighting to get a lot of this stuff out of the contract and the specifications. I do not think there is any engineer or contractor in this room but will say that any set of specifications they use would "bust" a contractor if the specifications were lived up to. If I go out and attempt to do engineering, I am told that I am not an engineer; and I frequently serve under engineers who were taught all they know of engineering under me and by me.

MR. PARKER: If the engineer referred to by Mr. Rockwood is present in the room, we should be delighted to hear from him.

CHAIRMAN OWEN: The Chair will endorse that suggestion. I wish to say here that this meeting is a matter of record in the history of the United States. I think it is the first time the contractors of this country have had a chance to heckle the engineer, and they have done it, and I do not know but that it has done them good.

CHAS. A. CARRUTH, (State Highway Department, Rochester, N. Y.): I think Mr. Rockwood should classify the engineers. We know there are many engineers who like to do what is right, but there is a system behind them, and they cannot. I am not knocking the state commission, but there is so much red tape that a man desiring to do what is right, cannot do it. A man is sent out on a road with a set of plans and specifications, and he is practically given no chance to use his own judgment. There was an order issued that no change should be made or allowed without the personal signature of the state and division engineer. I made a change at one time and I did not tell Mr. Rockwood about it immediately; but when I did, he told me many things. I think the state authorities should give the man out on the road more license. I was a contractor for two years, and I was up against the engineering department. There was a man there who was a good fellow, but he did not come often, and when he was around, you knew he was around. I had to do ninety per

cent. of the engineering on that road, staking and keeping track of his force; and yet he rubbed it into me as often as he could. I think the state officials should give the man on the road a little more control of the work.

J. W. BRENNAN, (County Superintendent of Niagara County): Mr. Chairman and Gentlemen of the convention:—I did not come here with any expectation of taking part in the discussion. I am a great believer in fair play. I believe the contractor should have his day, and he seems to be having it here; but I should like to see the other fellows have, not a day, but a minute.

Now, they haven't a "minute" here today. I am here, but I am not prepared to subscribe to the doctrine promulgated here that a college education—something which I have not had—is incompatible with the common sense so much talked of. It is my experience in dealing with people throughout our county—and I presume it is the same throughout the state—that every man has a good education or common sense, but that no man has both of them. I do not think if a boy is endowed with common sense, that a college education and an engineer's diploma will deprive him of it. I believe there are many men in the highway department of the state today, that have the college education and the engineer's diploma, and a large amount of common sense. I know of no class of men more possessed of the latter than the engineers in the highway department. We have heard them criticised here very severely and perhaps in some cases justly. My experience during the past two and a half years has thrown me into contact with probably fifteen or twenty of these young men with nothing but a college education—without experience, lacking common sense, and possessed of all the faults that the contractors complain of. But without exception I have found them to be pretty bright, intelligent, conscientious, upright, honest young men. You demand experienced men. Where are you to get them? We have not got the experienced men. Will it take a man of twenty-five any longer to get experience than it will take a man of sixty. Will a few gray hairs on a man's head qualify him to work more smoothly with a contractor than an abundance of knowledge?

Another thing I would like to say a few words on, and that is in defense of the specifications of the state of New York. They say we put too much in the specifications.

The contractors object to the clause relative to performing the work to the satisfaction of the engineer. They want to do away with that and leave everything to the engineer. They say there has not been engineering enough. The engineers are doing all the work they can do. If you have more engineers, there will be a howl that there are too many employes of the state. If the engineer makes the examination so that he can make absolutely accurate specifications, he must make engineering so much more expensive that the people will object to it. That clause, as it has been applied in our county, has been for the purpose of providing for such small contingencies as may arise in the construction of a road, for which the necessary investigation to determine the necessity of doing it would cost more than its actual performance.

One such instance came up in our county. One of the state highways was surveyed and we expected to acquire a right of way and make a straighter and shorter course than the old one. Owing to a difficulty in getting a right of way, we decided to follow around on the old highway route, which necessitated some more material of one kind and less of another. But if that clause had been taken out of the specifications, what could we have done in such a case? We would have had to readvertise and enter into an entirely new contract.

It is exceedingly easy for anybody to criticise any specifications or any method of doing certain things, without suggesting or providing a substitute. I would like to know what we are to do?

We heard yesterday that there was too much engineering; today it is more engineering that is wanted in order to make those specifications so definite that a man knows how many wheelbarrows of dirt and mortar he is to use. How can you reconcile those two things? How get your definite specifications without a greater force of engineers?

It was brought out that the contractor agrees that he takes the contract after investigations made by himself, and is not depending upon the estimate of the engineer. They say the engineers have ample time to make those investigations, but that is not my experience. The engineer has not so much time as the contractor, although it seems to be assumed that he has. It is not the case in this state—the contractor does not wait for the job to be advertised. There

are men poking around on our county roads, making investigations today as to where they can board the men on work that will not come up for five years.

I maintain that it is a perfectly fair and reasonable provision.

R. HOPKINS, (Troy, N. Y.): I want to pour a little oil on the troubled waters. As a contractor, Brother Rockwood has seen fit to talk on the faults of the engineer, and I, as a contractor, will tell a few of the faults of the contractor.

The old saying is that the world loves a good fighter but it does not love a constant fighter. The world has a lot of respect for a peaceable citizen who can fight hard when occasion requires, and the trouble with too many of our contractors is that we are looking for flaws too often. Now, the biggest thing a contractor can have in any way, shape or manner is his reputation. If he keeps that clean all the time, he can get along with almost anybody. The talks this morning were on the problems of the contractor, and my point of view is that the problems of the contractor would be fewer if he did not worry about the small things too much. If an engineer asks the contractor to do some work which the contractor thinks is extra work, and which approximates $25 to $50 in value, the contractor is foolish not to do it and smile. If he is asked to do $500 or $1,000 worth, he is foolish if he does not fight. The main thing is to know when to smile and when to fight. These things can be handled by diplomacy and by courtesy.

An ordinary contractor on a large piece of work, is in a complicated business and an isolated position; while a road contractor is going through a country where every farmer is supposed to know all about road building and where the contractor has to use a lot of diplomacy and courtesy all along the road. And they are the best two things that a contractor can have for getting rid of a lot of little worries that will otherwise cause him a good deal of trouble.

CHAIRMAN OWEN: There is another point on the program which is important. It is a matter that affects the contractors pretty seriously under the procedure under which they are acting. That is the question of bonds; and included in that question of bonds is the question of the maintenance proposition, for a period long or short, after the presumed completion of the work. I will state very positively —and I state it often—that if you had a perfect engi-

neer and perfect specifications and plans, a bond for maintenance would be ridiculous. An architect designs a house and the builder builds it, and he does not give a maintenance bond for a period of five years, or any period, as the architect is supposed to know how to put it up.

Now, this bond question is something on which I would like to have the contractors do a little more talking. It is a strenuous proposition. Take the paving contracts, for example. The former practice was to provide ten years' maintenance; and now it is five. That is for those specifications which the engineer is uncertain about. A contractor never gave a bond to put down a cobblestone pavement, but he does have to give it to put down an asphalt or a concrete pavement, where there is some mystery, and where the engineer does not feel that he is competent to determine positively.

MR. McEVOY: We have no choice in the preparation of our specifications, or in the manner in which we conduct our work, except to pay the pay-roll. The engineer puts his inspectors there and the work is done under their supervision. And after the job is done, they say, "We want to give you your money, but we cannot do it until five years have passed."

CHAIRMAN OWEN: The suggestion has been made that in view of the criticisms that seem to pervade the standard specifications of New York state—and I presume it might apply to other states—a committee of this association be appointed to confer together to see if it is possible to provide what you might call standard specifications that will be acceptable to both the contractors and the engineers.

We all understand that the varying conditions of climate and material in this country must prohibit standard specifications for certain details of construction. But the idea is that the form and the general details of the specification can be made standard.

Does anyone want to suggest anything of that kind? Is there any other point you gentlemen would like to discuss on the question of the relation of the contractor and the engineer? We have all made allusion to the labor laws, percentage bids and unit price bids; but there is one item, namely, the lump sum bid, that has not been touched.

In the state of New Jersey, the state contracts are all awarded under the lump sum plan. The work is all pre-

pared carefully, the quantities specified in the contract. The contract provides that the prices of the different items shall be submitted, and also a lump sum. So far in my experience that plan has worked very well. Mr. Hutchinson was the originator of that and he felt some doubt as to the wisdom of using the lump sum bid. But the experience of four or five years shows me it can be used with advantage. It devolves upon the engineer to see that his quantities are correct.

Another proposition that may come into vogue is the percentage bid. I have a contract of $500,000 or $600,000, in which we gave the quantities, specified the amount and specified the price in the specifications. Then the contractor in his estimate merely specifies the percentage of the cost shown by the estimate, for which he will do it, leaving out the problem of unbalanced bids. You have so many yards of earth, so many feet of curbing, and the engineer fixes the prices and the contractor goes in and says, "I will bid 101 per cent., or 98 per cent., or 90 per cent.

MR. ROCKWOOD: The percentage being based on the gross?

CHAIRMAN OWEN: Uniform percentage on each amount.

MR. ROCKWOOD: The quantities though, may vary in the construction and the percentage is based on the price per unit of each quantity.

CHAIRMAN OWEN: If there is no further business to come before this meeting, I declare it adjourned.

SEVENTH SESSION

Thursday Evening, November 16

The seventh session was held on the evening of Thursday, November 16, in Convention Hall, and consisted of three lectures on roads, which were illustrated by stereopticon views. The first, on European roads, was presented by Arthur H. Blanchard, Professor of Highway Engineering, Columbia University, New York City; the second, on American roads, by Paul D. Sargent, Assistant Director of the Office of Public Roads, and the third, on New York roads, by Fred Buck, Assistant Deputy, Bureau of Town Highways, New York State Highway Department.

Professor Blanchard first described the old Roman roads, showing a number of views of the Appian Way and describing its construction. He then passed to the subject of modern European roads, taking up first those of France. He showed a large number of views of typical French roads and of roads under construction. The art of building roads in France, he said, can be considered to have been developed during the past ten years, and then went on and described in detail the methods of construction and the equipment commonly employed. Most of the work with bituminous materials, he said, consists of surface treatment and was begun about nine years ago. In France, according to Professor Blanchard, the work of dust prevention is commenced early enough so that they have the roads dustless at the beginning of the season instead of at the end of the season, as is so frequently the case in this country.

He then described in detail the development of the methods employed in bituminous work, from the first work performed by means of hand pouring up to the present practice in which distributors of various kinds are employed. In this connection he showed a series of views illustrating various machines of both the gravity and pressure types.

Professor Blanchard also described in some detail the experimental work which is being conducted by French engineers through the Department of Roads and Bridges and a technical commission appointed for the purpose. European countries, he said, do not have the variety of materials for road building that are available in America, and very little is heard on the continent about the use of asphalts, tar being the most commonly employed bituminous material.

Passing to England, he described the roads of that country, paying particular attention to a description of the traffic to which English roads are subjected. In that country there is much heavy trucking done between the hours of midnight and six in the morning, in the marketing of produce. For a number of years the roads in that country have been subjected to a traffic in which there are many heavy motor trucks and trains consisting of a tractor drawing several trailers. The loads, he said, are enormous, and much attention is now being given to providing suitable

foundations to carry the weight. Another form of traffic peculiar to England, he said, is the passenger traffic between cities by means of motor busses. These are used extensively in England where trolley cars would be employed in this country, and the main country roads carry a large amount of that traffic.

He then described typical country roads, showing views of many such roads and also of the machines employed in surface tarring. At present, he said, there is much discussion as to the necessity of applying a covering of sand, chips or screenings after the application of bituminous materials, and, in some cases, this coating is omitted. There is also much discussion as to whether or not any considerable penetration is obtained when an old road is treated by means of pressure distributors. In digging up roads so treated after the application, he said, it is found that there is no penetration, the advantage of the pressure machine being along other lines.

He described in detail the Pitchmac construction, and the method of preparing the material. He also described the Tarmac road and the plant of Tarmac, Ltd., at Wolverhampton, and showed a number of views of it.

The last form of roadway described by Professor Blanchard was the Durax pavement, which is an English adaptation of the German Kleinpflaster. It is problematical, he said, whether or not this is the most economical form of pavement for the main roads on which it is employed, and the German and English engineers are keeping careful records to obtain data along this line.

The next speaker was Paul D. Sargent, Assistant Director of the Office of Public Roads, who talked on American roads, illustrating the lecture by a large number of views from the collection of the office.

The Office of Public Roads, Mr. Sargent said, confines its attention principally to country roads. The first pictures thrown on the screen showed examples of poor roads, illustrating the surprisingly bad condition into which roads in certain sections of the country fall when not properly taken care of. These pictures were taken in widely separated parts of the country and were typical of the unimproved highways in those sections. In connection with these were shown, in some cases, pictures of the same road after the systematic use of the road drag, illustrating the

results which may be obtained by the intelligent use of this implement. A number of pictures followed, showing relocations for the purpose of eliminating excessive grades or sharp curves.

Mr. Sargent then passed to the subject of bridges and culverts, and showed a series of pictures illustrating the various types, from the old plank box culvert to permanent structures of concrete. These views included several showing the proper and improper use of tile and pipe. Besides the culverts, several bridges were shown, the difference between good and bad construction being particularly emphasized.

Other pictures shown by Mr. Sargent illustrated the proper and improper use of gravel and crushed stone, both in construction and maintenance work; a macadam road in various stages of construction; good and bad roads, in which were exemplified good and bad practice in construction; a sand-clay road in process of construction, and the effects of automobile traffic on macadam and other roads.

These were followed by a number of views showing scenic roads in Yellowstone Park and elsewhere in America, the lecture being concluded with two views of a road before and after improvement, in the first of which two mules were shown drawing one bale of cotton and in the second two mules drawing twelve bales of cotton over the same road.

The last lecture was on the roads of New York state and was delivered by Assistant Deputy Fred Buck of the Bureau of Town Highways, New York State Department of Highways. He explained in detail the New York town system, and exhibited many views showing the work done and methods employed. These included views of improved town roads, with different surfaces, the widening of roads in the mountains, and maintenance work being carried on with drags.

He treated the subject of bridges and culverts at some length, showing an interesting variety of pictures. One of these showed a very old stone arch culvert which is still in good condition. Others showed the replacement of old wooden bridges with concrete structures.

He also showed views of construction work which illustrated the use of road rollers and traction engines for hauling machines of various kinds; a series of pictures showing

road drags of various kinds, and several series of views showing certain roads before, during and after improvement.

EIGHTH SESSION

Friday Forenoon, November 17

CHAIRMAN OWEN: Gentlemen, the meeting will please come to order.

I will ask the Secretary if he has any communications or notices to bring to the attention of the convention.

SECRETARY POWERS: We have a telegram from the Jacksonville Board of Trade, as follows:

"Mr. Harold Parker, President, Good Roads Congress: The Jacksonville Board of Trade and its Good Roads Committee wish you a most successful convention. You can count upon its most active moral support in any movement looking toward improved highways."

Among the invitations for next year's convention is one from the Chicago Chamber of Commerce.

CHAIRMAN OWEN: I would like to know if there is any motion or proposition to be presented.

MR. KENYON: Mr. President, I have a resolution that I would like to introduce. It is as follows:

"Be it resolved, That a committee of five men, versed in the repair and maintenance of roads, be appointed by the Chair to prepare and publish in the technical journals, as soon as convenient, their recommendations for standard specifications for the repair and maintenance of: First, earth roads; second, gravel roads; third, water bound macadam roads; and fourth, bituminous roads; and that the committee request all interested persons to mail their suggestions for amendments to the said specifications, and cooperate with like committees from other organizations.

"Be it further resolved, That the said committee be instructed to report its final recommendations to the next convention of this organization, to the end that standard repair specifications be there adopted."

And just a word in support of that resolution: I do not believe that an organization of this kind has any reason for existence unless it does something for all the people. Otherwise, it just brings to each one the education he gets from coming here, seeing the various exhibits, listening to

the speakers, and looking at the views as they are thrown on the screen. Each one of us may take that home to a great mass of people, and if you attempt to convey those ideas as standard opinion, people will say, "That is just his opinion. He thinks that is the way to repair or build a road, but I think different, and my opinion is as good as his." So, you only take that something back for yourself. It becomes part of you.

It seems to me that we should do something that we can take back, that will be good for that class of people. If we take back something that represents, say, the opinion of 100 men, or of a convention, we can say, "There is a thing we have all agreed upon that is standard." Then when I say to my people, "That is something that should be done," they cannot say, "That is Mr. Kenyon's idea, and I think different," for I can say, "No, that is the opinion of 500 men and not Mr. Kenyon's opinion." Then they will say, "That is the best thing to do."

So, I repeat, unless we do something that helps all the people in a bigger way than simply educating ourselves, we are not doing our full duty, and acting upon that thought, I introduced this resolution.

I had occasion, a short time ago, with twenty men, to go to our county officials with regard to the repair of some roads. Some of the officials were farmers, and some of them were men who had had some little experience in this work. and I said, "We want to call attention to the condition of these roads. You are spending money on them. Why don't you repair them properly?" They said, "What do we know about repairing roads? Show us something standard instead of just throwing gravel on the road, and letting the traffic trample it down." I suggested one way, and they said, "We don't know how to build roads." "Why not get an expert?" said I, and they replied, "We cannot get engineers for a dollar, or a dollar and a half a day, but if we had a standard we would adopt it."

Now, what better work can this convention do than formulate standard rules and regulations for the repair and maintenance of this class of highways? It is a question that is coming before the people every day. You can put the mark of approval of this convention on that, and then some official in a small out of the way town can point to that method and say, "That is the way 500 or 1,000 ex-

perts say is the proper way, and we will hereafter do it in that way." Then have we not done something for the benefit of all the people? I move the adoption of the resolution.

C. C. BROWN (Indianapolis, Ind.): I want to second Mr. Kenyon's motion, and I want to give a little history of what can be done by this work: I am a member of the American Society of Municipal Improvements, which is made up of people connected with the public works or construction departments of the cities. Mr. Owen and myself both happen to be past-presidents of that association, and we are members of what is called the Committee on Standard Specifications. We have found from time to time during the history of the organization that it was necessary, or was at least very desirable, to have some standard, upon one thing or another, and we have adopted such standards for one reason or another. And when we have adopted a standard of that sort, it has been accepted generally. And you will find very frequently in the specifications for municipal work, that certain things are to be done according to the "standard specifications of the American Society of Municipal Improvements." That is a basis upon which any city can work.

About three years ago we came to the conclusion that it was desirable to have a full set of standard specifications for city work, and a committee was appointed for that purpose. We have appointed from year to year under that committee, sub-committees of experts in different lines. There are committees on asphalt, bituminous paving and sewer specifications, and so on. I think there are about half a dozen altogether. We have adopted some of these specifications already. The asphalt specification was adopted a few weeks ago, and some of the others are still open for further discussion. But the same thing is happening with reference to those specifications. In the older specifications prepared by city engineers and others, you find reference to a standard specification adopted by the American Society of Municipal Improvements, and it is evident that the adoption of these specifications as standards has been of great assistance to many cities not connected with the organization, but who simply follow its lead.

We have a sub-committee on bituminous pavements, and

I will take it upon myself as chairman of the general committee to say that we will take up this matter of road repair, included in this resolution, under that committee, or we will have a new sub-committee appointed to take up the matter. And we will be glad to cooperate with this association or any others engaged in the same way. So I want to support Mr. Kenyon's motion simply because I know from experience that it is a very valuable course of procedure.

CHAIRMAN OWEN: Any further remarks on this resolution? I would suggest the incorporation in the resolution of the method of the payment.

MR. McEVOY: Does that include construction too?

MR. KENYON: That is including too much in the resolution.

(Resolution seconded, stated and carried.)

CHAIRMAN OWEN: The appointment of a committee will be in the hands of the president of this association, and he will appoint and announce it later.

Now, gentlemen, we will take up the regular order of business for the day, and you are relieved somewhat of the burden of an introduction to the speaker, as the chairman and the speaker in this instance are the same for the first paper.

MAINTENANCE OF ROADS AND PAVEMENTS

By JAMES OWEN
County Engineer, Essex County, New Jersey

The writer of this article would have preferred that the title of this paper should have been the economics of roads and pavements, as he sees that at this stage of road development the financial question is paramount. But as finally the maintenance problem is the one with which to deal, the discussion of that feature will of necessity include the money end, so it is hoped that undue stress upon what is sometimes too apt to be ignored in engineering in the means of construction as well as the methods will be pardoned.

In discussing the pavement problem in such an extensive country as this, with its varying climate, topography, materials to be used and habits of the people, it would seem impossible for any one individual to cover the whole ground, as, of necessity, each man's environment and experience are limited. Yet the aggregate of such experience will be of

value to all. So if in these remarks statements at variance with the ideas and experience of other members of this convention are made it is hoped that prompt repudiations of the statements will be evolved, as by such means will accurate data be accumulated.

To properly consider the subject in its entirety it may be wise to indulge in a classification of the people, the pavements and the pay. The traveling people may be divided into urban, suburban and rural and it may be confidently stated that the requirements of the pavements differ in character practically in accordance with this division, except that there may be a certain overlapping due to special conditions. This covers two heads. The ability to pay varies spasmodically with climate, topography and the energy of the community.

Now enters into consideration the character of vehicles of which there are today two, self-propelled and horse-drawn. Both of these may be divided into fast and slow moving, the heavy wagon and light buggy, the motor truck and the automobile, these introducing still other items, the iron tire of the wagon, the solid rubber of the buggy, the corrugated tire of the motor truck and the pneumatic tire of the automobile. All these factors vary in weight and speed and their effect on the surface of the pavement is of vital importance.

Another point, which has not yet arisen, is the effect of different pavements on the tires of vehicles. So far, the owners of such vehicles have been so busy trying to get something smooth to ride upon that they have been content to pay their bills for new tires and new wheels ungrudgingly, yet in the future it will be an important economic factor.

There is still another factor which today is the most important in road construction, viz., the suppression of dust. Also, there enters in, to a lesser degree, the suppression of noise in cities.

Taking all the factors outlined heretofore, the problem is to furnish a pavement that is smooth, durable, dustless and cheap; and that problem is today facing the civilized world. It is not my intent to dilate very extensively on the paving of cities, as practice in that branch is being slowly crystallized and the principles governing it are giving good results. Classify city traffic into business trucking, arterial com-

munication and purely local distribution, with the use of the following standard pavements, wood block, granite block, Medina sandstone, brick, asphalt and the tar compounds, and with proper care in the selection and manufacture of material and a conscientious disposal of it in place, and in most cases a smooth dustless pavement will be secured. But here enters the question of maintenance and also the traveling factor. At the same time there arises a controversy between drivers of horse and motor vehicles on the question of smooth pavements, the horsemen claiming that the smooth pavements, like wood block or asphalt, are impassable and useless at certain periods for heavy hauling and should not be tolerated. That at seasons their slipperiness is detrimental is not doubted. However, this point is one for purely local consideration and cannot be generalized upon.

Cobble and old fashioned granite block are certainly permanent but not desirable. The close jointed grouted granite block and the Medina sandstone would seem to be ideal. They are smooth, and once down relieve the maintenance department from attention for a generation. Wood block as now laid is desirable, smooth, and, at times, slippery, but its permanency is unknown.

The brick pavements of today are desirable and appropriate especially in districts where there are no stores. Here it is proper to make the statement that many paving brick manufacturers are setting an example to the community in concentrating their efforts on making and delivering the best possible brick, relying more on the character of the material than on their profits for future prosperity. The writer suggests this example to other industries. Brick pavements as now constructed also relieve the maintenance department, if proper care is used in discriminating on certain character of travel. Where there are extraordinarily heavy loads and dense vehicular travel, it is not wise to use brick.

We now come to the mastic propositions in which the maintenance department sooner or later takes an interest. The asphalt and tar preparations give a smooth, dustless and serviceable road, and are desirable for residential sections and in many cities are universal. Their maintenance is carried on in different municipalities in different ways, some owning their own repairing plant, others contracting

the repairs, and still others neglecting them altogether. It is safe to say, however, that after five years' use of these pavements the item of repairs begins to be a factor, although the writer has one asphalt pavement which has been in use for nearly ten years without repairs or apparent necessity for them.

Interjected into many cities is the use of cheaper pavements for purely residential streets of both high and humble character. Sanitary precautions in some cases cause their existence before the demand is made by the residents who often are not able or willing to pay. In other instances they are laid at the desire of the property owners, and in these the maintenance problem soon appears, and the practice there can be considered the same as in suburban communities.

In street development in suburban communities or small towns there are new factors to be considered. Except in main thoroughfares the travel is light. The unwillingness to pay large assessments and also the suppressing of dust has opened the field to endless inventions with varying materials to provide cheap, smooth and dustless pavements. All kinds of panaceas have been promoted and enormous sums of money have been expended in experiments, and it is to be hoped that in the near future a practice may be adopted available to all within their means. This same idea extends, to a degree, to rural highways, and it would seem desirable to discuss the problem as common to both classes of communities.

To properly appreciate conditions it would be well now to consider what these pavements, so-called, have to endure. With horse-drawn vehicles and steel tires, the roads were constructed to be available for such use and the standard generally adopted where material was convenient was the macadam or telford pavement, using the local rock if possible, but in many cases bringing it from 200 to 250 miles by water or rail. Where rock was not available, other natural materials were used, such as gravel, shale, chert, sand and clay, and in the arid sections, clay and oil. The success of these pavements when properly constructed and maintained gave an enormous impulse to automobile travel, in some cases causing it to supersede horse travel. The rapid increase of automobile travel, however, speedily began to impair the surface of the highways and pave-

ments, and also created volumes of dust. This condition started new ideas and new investigations, of which we are now in the throes.

Careful comparison of the effect of iron tires and shoes and rubber tires on road surfaces shows a marked difference in their action. Under the old order of things, if a coating of broken stone or gravel were placed on a highway it was confidently expected that the surface would soon be consolidated. It was probably wearing out the patience of the traveler, but showing that a consolidatory effect was obtained. The writer has made experiments with automobiles, at low and high speeds, both on macadam and gravel surfaces and finds that their action is disturbing, the higher the speed the greater the disturbance created. There are, therefore, two opposing factors in the maintenance of present highways and the resultant is determined by the preponderance of certain kinds of travel. Where the wagon travel is universal the old conditions exist and the old practice may prevail, and where the automobile is universal, an entirely different system of maintenance has to be followed. But where there are equal volumes of the two kinds of traffic the greatest difficulty exists. The question of the future must now be considered. Will automobile travel entirely supersede wagon travel or will the traveling still be mixed? It is well accepted that there is a great growth of automobile use and a great diminution of horse-drawn vehicles and the decision of such a factor is purely local.

Another very important factor is the suppression of dust, and here the writer wishes to enunciate the fact that the automobiles themselves are not the creators of the dust, as is generally considered. The steel tire with its grinding action creates the dust and the automobile with the wind, disturbs and scatters it. As a proof of this a coating of screenings laid in late spring on a road carrying only automobile travel will still be in the same condition in the fall, merely disturbed, but not consolidated. And there will be no dust.

Taking these facts as axiomatic, the maintenance of all pavement surfaces liable to wear must be considered as a purely local problem governed entirely by the local travel. The dust question has this peculiarity: It may be more troublesome on a less traveled highway. This question,

while of somewhat recent origin—that is to say, while there was always plenty of dust, the public for some occult reason did not complain of it—is really the governing source of all new efforts at road making, and is just as much of an economic problem in rural communities as it is in urban. The impairment of the value of crops, especially fruit, is an accepted fact and the demands for suppression are insistent and imperative. In the effort at dust palliation a large amount of gray matter has been expended and a great many expedients have been devised. Setting aside the experience of the French engineers at Algeria where the first experiments in dust suppression were made with the oil of Massat, the California practice was really the first that did not use water. But we all understand that water was the first material used for dust suppression, whether by rain or the watering cart. In southern California there is little or no rain and the heavy mineral oil was used, first by surfacing the adobe soil with clay and then sprinkling the oil. This gave good results and an application twice a year proved satisfactory.

This idea spread and the practice of using crude oil for surfacing came into vogue. The smell in the houses and the ruination of carpets and clothes stopped its use and then oil, without the smell, was manufactured, and with some of the stickiness eliminated. These oils generally with asphaltic bases gave general satisfaction and are now in general use. The idea, however, was prevalent that a dustless, smooth, permanent surface could be devised that would be cheap and effective, and such surfaces have been provided, but the question of cost then becomes the vital point.

The original experiments made by Mr. Blanchard of Rhode Island in resurfacing roads with asphalt or tar mixtures and the reasonable low cost with good results after a limited period of use encourage the whole country, as well as the writer to be up-to-date and do likewise. It must be understood that those experiments were made by a competent engineer with selected help. When, as is often the case, communities do not employ a competent engineer nor have selected help, however, very different conditions prevail.

The writer started on the unknown path and resurfaced miles of roads with heavy asphalt oils by the penetration

method, and also drew specifications for new roads to be built by the same methods. The results, however, were so unsatisfactory that the practice both in old and new work was quickly abandoned. Subsequently contracts were made for work by the mixing method both by cold and hot application and results from them have been satisfactory. The final practice arrived at by the writer is to build his roads by the old water bound method and then apply a light surfacing oil at the proper season to allay the dust. This is found to give the smoothest pavement for the least money on an average country road in New Jersey where there is a large automobile travel.

The experiences in the penetration method were peculiar and there was also a curious case from the fact that the engineer was compelled to rely upon the chemist for his data, accepting such data even though based on meager procedure. The question of manipulation by the labor available became more of a factor than the chemical data. Men of experience in the old practice were at sea in the new methods, and in one case, even though an expert was called in and special men were employed, the result was unsatisfactory, from an engineering standpoint. It is true a certain percentage showed good results but forty per cent. efficiency is not ideal.

In one instance a section of newly built road a mile in length was finished in the fall and presented a good, smooth surface. In the spring, however, the surface broke to pieces over the entire length and had to be renewed. In other cases the rolling of the surface mixture into waves practically put an embargo on travel and the surface had to be entirely removed. In another case a rut six inches deep and half a mile long appeared with no apparent cause. With such experience the writer may be excused from indulging in any more surfacing escapades.

With the mixing process better results have been obtained. In one case, with a hot mixture, the surface, after being rolled and having cooled, was a series of waves. Curiously enough after eighteen months of travel these waves disappeared and a smooth surface now exists with no appearance of wear.

The cold mixture gives excellent results, producing a surface that is smooth and equal to asphalt.

A few experiences in surface oiling may be interesting. In maintaining a system of 150 miles of road with city

and suburban travel a complete system of repairs is obligatory and breaking the continuity of such a system leads to complications. As the demand in the writer's section for the suppression of dust was in the spring it was considered desirable to find an oil that would last the season. It did last the season in most local cities, but such an oil ruins the surface of a pavement, creating a pitting which is very objectionable. This heavy oil of course prevents the ground particles of the road from being blown away but when it rains an emulsion is formed which is of great local objection. Therefore it was found advisable to use a lighter oil with more frequent applications, and with such practice no impairment of the surface is presented. With the practice of repeated applications of dust preventives the use of materials not containing oil may be advisable, depending of course on the system in vogue and the cost of the material itself. Some of these the writer has tried but so far not with the success anticipated. In residential localities these preparations are of advantage as no oily particles of dust are carried into the houses or on the clothes of wayfarers.

There is one other point that the writer wishes to emphasize, and that is that with the growth of automobile travel the character of the mineral aggregate in any mixture is of secondary importance. Under the old conditions, hard trap rock was ideal and was used wherever available, even when long hauls were necessary. Such an insistence is not now necessary as it is found that with the grinding eliminated and the use of surface oils, good gravel gives as excellent results as the trap rock. Granite can be used with impunity, and such natural materials as chert and shale can also be used. The sand and clay roads of North Carolina can, with oiling, be made into perfect roads as is shown in California. A full appreciation of such a fact will reduce the cost of thousands of miles of roads in the future.

The writer now wishes to allude to the financial problem in road construction, and it might be well to note the varying channels from which money comes. Taking my own state as an example, these are as follows:

City street paving.—A part, say about 80 per cent. on property, balance on the city at large. Maintenance a city charge.

Suburban towns.—Streets macadamized 16 feet wide. A general tax; extra width local assessments.

Rural towns.—Mostly developed by either state roads or county roads.

County roads.—Main arterial highways paid for on bond issue of the county; maintained by the county. County road repair system abandoned when state roads came into use.

State roads.—State pays 33 per cent., county 56½ per cent., town, 10½ per cent. Maintained by the county with contributions from the state of automobile money, say 20 per cent.

With such varied methods of payment for original construction it is to be noted that the maintenance cost is defrayed by either the county or municipality, with the addition of a small amount from automobile taxes. Now enters the important part of the whole question of road and street maintenance and that is the ability and willingness to pay.

As to ability that is a condition hard to gainsay. As to willingness that can be overcome by education. To properly educate a community to higher ideals and standards, those ideals and standards must first be crystallized on a permanent basis and then set before them.

In too many cities of the United States there are rough and unsightly pavements tolerated by educated people and traveled over with repugnance, yet there they are. In country districts where good roads have been made they have been allowed practically to disappear through neglect. In other communities the desire for the ideal and also the willingness to pay are both present yet the supply of talent and material is deficient.

So in this question of road surface maintenance the practice in cities is fairly conceded to be beyond controversy. Only the money is required.

In suburban and rural highways this problem confronts us: In days before the automobile, with wagon travel alone and with a system of roads in cities, towns and country, the average cost of macadam repairs was three cents per square yard per annum. This by increased travel, increased cost, and automobile has now raised the cost to six cents, and the oil at one cent brings it up to seven cents per square yard per annum for having and keeping a smooth oil surface.

Rejecting the penetration method as erratic and uncertain and applying the mixing process the cost runs from 80 cents to $1.10 per square yard. Consequently the mixture has to last ten or twelve years to be equal in actual cost to the oiled macadam. Another item enters in. The renewal by mixing, of 150 miles of road 16 ft. wide at say 90 cts. would cost $8,300 per mile or a total of about $1,245,000. As this would have to come out of the annual appropriation, whatever money was expended in the mixing should be made a separate item, otherwise the maintenance account of the balance of the roads would show a shortage and deterioration would ensue. This has been the experience of many communities and great dissatisfaction has been the outcome.

In conclusion the writer hopes that in the near future the mistakes and experiences of different men in different sections may bring the practice of road repairs into some definite shape, both as to construction and financing. The community, including the road wearers and taxpayers, want good roads at the lowest cost and are willing in most cases to furnish the money if good results can be obtained. It is the province of this association to supply the demand.

CHAIRMAN OWEN: There are two gentlemen set down for formal discussion of this paper, one is Mr. A. W. Dean, Chief Engineer of the Massachusetts Highway Commission, and the other is Mr. J. C. Travilla, Street Commissioner of St. Louis, Mo. We will first hear from Mr. Dean.

MR. DEAN: Mr. Chairman and Gentlemen:—Before criticising Mr. Owen's paper I will make a few remarks on interurban and rural roads.

We have in Massachusetts about 850 miles of highway, owned and controlled absolutely by the state, through a state highway commission. Up to the year 1908 the state highways were nearly all constructed of ordinary water bound macadam, using telford wherever it was necessary on account of poor subgrade. In 1908, a commencement was made with the use of bituminous material, not, however, in the construction of the road, but as a surface application to save the roads from the destructive effect of the automobile. During that year there were perhaps ten miles treated with what we now call a light oil, that is, an oil that does not require heating before

application. In 1909 more miles were treated, and the same roads which were treated the previous year were again treated, as the light oil did not last but one season, and in most instances not very effectively for a whole season.

At the present time we have about 500 miles that have been treated with some sort of bituminous binder.

The commission does not treat the roads for the purpose of laying dust, but simply for the preservation of the surface. If dust laying were one of the prime objects, it is possible that a different material might be used than that which has been used, but for the preservation of the surface, the heavy bituminous materials have given better satisfaction than the light ones.

The material we have used more than any other is a heavy asphaltic oil containing, as the dealers claimed, ninety per cent. or more of asphalt. This oil to be applied must be heated to about 250° F. While this oil has not been satisfactory in every case, it has been satisfactory in a great many cases, and we have many miles of oiled roads which were treated with a ½-gal. application of this heavy asphaltic oil, early in the season of 1909, so that they had practically all of that season's traffic, and today they appear to be good for one or more year's traffic. And very little patching or repair work has been done upon them. Others have lasted—I think the minimum was about one month—where the same method was used and the same material as in the treatment of the roads that have lasted three seasons. But this was due partly, possibly, to the poor quality of material, or some peculiarity of traffic conditions. There are a few conclusions that can be stated definitely regarding the use of bituminous material as a surface application:

First, no surface treatment of a road will be satisfactory unless the road is thoroughly cleaned of all particles of dust and dirt before the oil is applied; otherwise the oil is bound to peel up as it will not penetrate and stick where dust exists between the surface and the road metal.

Second, about one-half a gallon, that is, to the square yard, is necessary on a road that has not been treated before. That appeared to be sufficient. If a road has

been previously treated so that there is a certain quantity of oil remaining on it, a lesser amount may be used. In the application of this one-half gallon of oil, we have found it preferable to put it on in two ¼-gal. applications, preferably under pressure, rather than in one ½-gal. application, as when it is put on at a single application, it creates bunches and ridges by running to the sides. Where there is a ¼-gal. application made, the oil stays just where it strikes the road.

Third, after the oil is applied, the road must be covered with pea stone, fine gravel, or coarse sand, for a period depending more or less upon the climate, until all the sand or pea stone or gravel that the oil will take up has been absorbed, otherwise it will soon be picked up by the wheels of automobiles, and leave holes which grow deeper unless immediately patched.

Fourth, the use of heavy asphaltic oil (the so-called 90 per cent. asphaltic oil) is not advisable where the predominating traffic is of heavy horse-drawn vehicles with iron tires.

I have in mind as examples, three roads treated last season at about the same time with heavy oil. A section one mile long was practically gone in about three weeks in one case, and in another case a section a half mile long was gone in less than a week, the destruction being caused by heavy ice teams on steel tires, the iron shod feet of the horses contributing also.

On these same roads we have tried tar and light oils with little success. In those cases where the traffic is of that character, it is probably necessary to loosen the road surface, and incorporate with it some binder that will go down and be incorporated with the stones and not lie on the surface as a blanket to be picked up by vehicle wheels.

The cost of blanket application in Massachusetts has averaged eight cents per square yard for an application of a half-gallon; whether in a single application or two quarter-gallon applications, the expense being very nearly the same.

Figuring the cost of such maintenance on the annual basis, it is probably impossible to give any definite estimate at the present time as the length of life and the varying materials and the varying traffic have such dif-

ferent effects that we cannot reach, without long experience, any average annual cost for these roads. A road which lasts five years, as we hope some of our roads will, with a little minor patching, costs for the first application, eight cents per square yard making the first year's cost $700 per mile for a 15-ft. road. If that is divided over five years, and $20 per mile per year allowed for patching, then the average annual maintenance cost per mile per year is only $160.

Mr. Owen in his paper made a statement something like this: That he had rejected penetration as erratic. Is that right, Mr. Owen?

CHAIRMAN OWEN: That is right.

MR. DEAN: I think Mr. Owen has put that strongly. In Massachusetts we have used the penetration method to a considerable extent. One road which has been down three years was constructed by the penetration method, using a tar which, at the time, the division engineer and the resident engineer were going to send back as being good for nothing. That road has had no patching whatever, and has stood up three seasons with practically no repairs. So, I do not think that under those circumstances we want to reject consideration of the penetration method.

We have other examples of roads built by the penetration method in 1909 and 1910, similar to the one I have mentioned. Several miles were built last year by what might be termed a penetration method—we call it the modified Gladwell system for lack of a better name—in which we penetrate the upper course, upward and downward. We put on our course of bottom stones, then generally, three-quarters of a gallon of oil, and then spread what will roll to two inches of No. 2 stone (stone from half an inch to an inch and a half), roll that some, then apply about five-eighths of a gallon on the upper surface, then cover with pea stone and thoroughly roll. That is surely not a mixing method, and I think it is safe to call it a penetration method. We built several miles of that road in 1910 that are as good today as when the contractor left them, and have had no repairs, except upon a square yard here and there. Therefore I am not prepared to agree with Mr. Owen that we should reject penetration as erratic.

MR. McEVOY: Are these subjected to heavy team traffic?

MR. DEAN: Yes, sir; but wherever we have very heavy team traffic such as exists on the road between Boston and Lynn, we have used the mixing method. We did not try the penetration method; we mixed, as we felt we wanted to be absolutely sure, and we could not then apply the heavy asphaltic material we wanted to apply by any spraying or penetration method.

Mr. Owen also stated that soft stone could be used where a bituminous road is constructed. I agree to a certain extent, but I think there is a limit. Any stone which will crush under the roller, is, in my opinion, objectionable.

We have an example right on the borders of New York state, in Massachusetts, on a road built with this soft stone. About a month after it was completed, it was rutted, and it was found that the ruts were due entirely to this soft stone, which had crumbled up. The subgrade was satisfactory, but the stone had become powdered and caused ruts. Hence, I say any stone that will crumble and break under the ordinary ten-ton steam roller would not be a suitable material, even with the bituminous material used for a binder or a surface application on the road.

Another statement by Mr. Owen that I think is open to considerable discussion, was that the use of heavy oil on the surface of the roads in wet weather muddied up, and became what we term "mushy."

We have used heavy oil and the heavy grades of tar in Massachusetts, and we have not had that occur in any case that I can call to mind. It has occurred where we have used oils or tars which required no heating, but in no case have we had any complaint or trouble due solely to the oil muddying up on account of weather conditions. It would soften slightly during long wet periods, but always become packed with the travel after one fair day. I presume possibly my criticism of Mr. Owen's statement in this regard may be due to a lack of uniformity in describing oils and tars. Many road makers call a "fifty per cent." oil heavy, while others consider it light oil.

Gentlemen, I thank you for your attention. (Applause.)

CHAIRMAN OWEN: I am very much pleased at the meeting and the attendance. We will have time to have

another discussion read, and then we will have the afternoon for general discussion and criticism and I want all to be heard and to take part in the discussion, and take advantage of such information as you can get here; and I further want every man who can, not only to tell his successes, but his mistakes as well. Let us all know. We all want to know where we have made mistakes in the road business. Don't be afraid to speak out. I am an old man, and I have made them, so the young men need not be afraid to tell theirs.

The discussion now will be by Mr. Travilla, Street Commissioner of St. Louis. He will give the Western idea of this road movement. I will ask Mr. Meeker to read the paper as Mr. Travilla is not here.

MR. TRAVILLA: (Paper read by Mr. Meeker)—In discussing Mr. Owen's interesting and valuable paper, I fully realize how at times he has been disappointed with the result of his labors, having, myself, had many such experiences in carrying out similar work as Street Commissioner of the city of St. Louis.

The title of the paper, "Maintenance of Roads and Pavements," and the suggested title, "The Economics of Roads and Pavements," to me are directly associated. The failure to properly consider the economy of the construction has been a cause of much expense and trouble in the maintenance of our highways. The highway engineer in adopting specifications for road and paving materials and for the manner of construction must be governed by local conditions, such as the amount and character of traffic, gradients, climatic conditions and realty values. These salient features determined, the character of the improvement should be such that the maintenance of the road or pavement will be reduced to a minimum. It follows, of course, that in any form of road or pavement construction, no wearing surface will last indefinitely and not wear out; which fact means that the patrol system of maintenance should be installed at the time the work is accepted.

Because of the amount and character of the work coming under his supervision, the opportunities offered the Street Commissioner for the study and investigation of the subject under discussion have been unusual. The plotting, construction, maintenance, cleaning and sprinkling of 930 miles of streets and 320 miles of alleys come directly under his

supervision. In my judgment, fixed responsibility, under this system, is the only proper way to supervise the maintenance of the highways. Practically every kind of road and pavement construction, with the consequent necessary maintenance has been tried, the successes and failures being carefully noted in each case. Before discussing the maintenance of the cheaper forms of highway construction, I deem it advisable to go somewhat into the details of maintaining pavements of the first class; that is, those adapted to city streets.

A sufficient number of maintenance gangs, skilled in their particular line of work, and in the employ of the municipality, is the best method of maintenance. A grouted vitrified brick pavement is the most expensive to repair, since the cement grout prevents any future use of the old brick. For this particular reason, I favor a weak grout of about one part cement to three parts of sand. In the grouted brick pavement, points other than the quality of bricks must be given consideration. Our experience has been that the majority of failures in our brick streets have been caused by expansion and contraction stresses, rather than by any inferior wearing quality of the bricks. This, then, resolves itself into a problem of proper construction, climatic and traffic conditions to be given careful consideration.

The cost of maintenance on vitrified brick pavements, due to wear and tear, after a period of four or five years, on streets where traffic conditions vary from 1,000 to 3,000 horse-drawn vehicles per day, varies from one to four and one-half cents per square yard per annum based on the total paving area of a contract of from 8,000 to 12,000 square yards. The life of a brick pavement under such traffic may be placed at from ten to fifteen years. After a period of ten years' use, the cost of reconstructing a brick pavement, including labor and fifty per cent. of new brick, has averaged fifty cents per square yard. The cost of small repairs has averaged ninety cents per square yard.

After a period of five years, the cost of maintenance on asphalt and bitulithic pavements has averaged from one to four cents per square yard per annum, based on the total paving area. The cost of maintenance on asphalt and bitulithic pavements may be materially decreased after they have begun to age and wear, by the judicious use of a

squeegee or flush coat of asphaltic cement and a covering of sand. This coating or waterproofing of the old pavement helps to build up the wearing surface and replaces some of the bitumen that has become inert. The cost of this class of work will average from three to four cents per square yard. Small repairs on asphalt and bitulithic pavements average from sixty to ninety cents per square yard.

The cost of maintenance on wood and granite block pavements has been less than that on any other class of paving material. The only maintenance expense on wood block pavements was due to the few expansion troubles which usually take place during the first year the blocks are down, and in covering the surface with sand on account of the "bleeding" of the blocks. This additional expense does not exceed from one to two cents per square yard, based on the total paving area under contract.

Wood block pavements have been in service in this city for a period of more than nine years, without any cost for maintenance due to wear and tear, and indications are that the life of wood pavements here will average from fifteen to twenty-five years.

In determining the class of paving material best adapted to certain streets and the future maintenance of street pavements, due consideration should be given to the character of traffic—whether horse-drawn or motor-driven vehicles are in excess—the average tonnage per day and the average tonnage per foot of roadway. The results of some of our investigations indicate that when the average number of horse-drawn vehicles exceeds 2,500 per day, equivalent to 15 tons per foot of roadway, the traffic is too heavy for asphalt or bitulithic pavement, and that wood block or stone block is best adapted to paving purposes under such conditions. When the average number of horse-drawn vehicles exceeds 1,000 per day, equivalent to 9 tons per foot of roadway, macadam pavements will not render economical service.

After a period of several years, wood block pavements laid on streets where the average number of horse-drawn vehicles exceeds 2,500 per day, equivalent to 23 tons per foot of roadway, show no appreciable wear and consequently no expense for maintenance. Outside of the warehouse and railroad districts of our city, where granite block is recommended to be used exclusively, wood block is the material best adapted to heavy traffic.

The advancement made in waterproofing and bonding macadam and telford roads and pavements with bitumen is attracting greater attention today than that of constructing the standard pavements. The successes and failures in what may be termed "up-to-date" methods have been numerous with highway engineers who have been in a position to experiment with the different methods that have been recommended. Speaking from my experience, the failures that have taken place may be attributed to lack of uniformity, which may be in the grading of the mineral matter, the application of the bitumen, lack of knowledge of the effects of road temperatures on the bitumen and the amount and character of the bitumen used. A road surface, to maintain its contour and wear uniformly, requires a base of sufficient depth to carry the superimposed loads, possessing the necessary density but not holding moisture. The "waviness" of road surfaces referred to by Mr. Owen may be attributed to some of these causes. The bitumen whether applied by the penetration or mixing method, should be of such consistency that it will not be extremely soft at high temperatures nor brittle at low temperatures. An excess of bitumen may cause failures, but the impact and wear from abrasion must be removed from the road metal by the use of sharp sand. This type of construction, whether used in suburban communities or rural districts, may be recommended. This statement is made after careful study of the subject for more than four years, together with the actual experience with at least fifteen road sections subject to all classes of traffic.

With the constantly increasing use and desirability of the more rapidly moving motor-driven vehicles, will not the problem of the future resolve itself into the construction of a smooth roadway surface capable of withstanding the wear of solid rubber and pneumatic tires? The pounding effect of calks and the grinding of steel tires on the modern paving materials being reduced to a minimum through the increased ratio of motor-driven to horse-drawn vehicles, will not the disagreeable feature of noise, associated with some of the modern pavements, tend to eliminate itself? The roar of brick and the rattle of granite block pavements would both disappear under these conditions. Providing a cushion coat on the rims of the vehicles using the roadway would have the same effect as making

the pavement proper more noiseless. Then, going a little further, as Mr. Owen says, smooth pavement surfaces will result in a greater mileage for tires and hence a more economic service of the motor car. Less grinding of the roadway metal by steel tires means less fine material on the surface and the increased life of an oil treatment with a consequent lesser cost of oiling per square yard per annum.

Too much stress cannot be placed on the remarks of Mr. Owen that in experiments made by a competent engineer with selected help, good results have been obtained. Many of the highway builders are being furnished with "dope" distributed by the manufacturers of road bitumens and by their representative salesmen, many of whom have little real knowledge of the science of road and pavement construction and maintenance. Photographs of good roads built with their products are everywhere in evidence. But has the attention of the highway engineer been called to the failures in road construction where these same bitumens have been used? The analysis of bitumens made by the chemist doesn't mean much to the engineer handling these products on the job. Most of the asphalts on the market today will meet the accepted tests for asphalt, and as for coal tar products, I have failed to find them uniformly satisfactory. This criticism is not offered in the spirit of being antagonistic to the manufacturers or the salesmen of bitumens, but to call attention to the difficulties encountered in endeavoring to get uniform results in the construction of highways by what is considered the best practice.

In the treatment of road surfaces with oil and oil asphalt, Mr. Owen refers to having started on the "unknown field" and abandoned the construction of roads by the penetration method and the resurfacing of roads with a heavy oil. This is not surprising since the path "blazed" some years ago in this city in obtaining knowledge on the subject, must be retraced each year and the road surface covered with sand or stone chips to take up the excess of bitumen. Fortunately, the amount of work done was on comparatively short sections of the highways, but the lessons taught in these experimental sections have furnished information that is now proving of value to us. The uniformity obtained by the mixing method accounts for Mr. Owen's pref-

erence for this method of construction. In residential districts, heavy oil, properly and thinly applied, outside of its greater life has an added advantage. It happens at times that shortly after oiling, a heavy shower will fall. In properly shaped roadways this means that most of the water will find its way to the gutter, if there be one, or at least to the edges of the roadway. The lighter the oil, the more oil will the water carry off to the side and the more pronounced will be the resulting oil stain on the grass or on the granitoid gutter when the water has found its way to the drain.

The oiling of road surfaces, to get the best results, requires not only a knowledge of the oil, but necessitates an equipment to properly handle the same. I should say that the "pitting" of the road surface referred to may have been due to several causes, to wit: Dust on the road metal; lack of uniformity in the application, and the low temperature, of the oil; excessive amount of oil per square yard and the failure to properly cover the same with sharp sand or stone chips.

We use annually from 300,000 to 400,000 gallons of heavy residuum oil on all classes or roads and pavements without receiving a protest from the householder or automobilist. Without proper facilities for the heating and spraying of the heavy oil, I recommend, as Mr. Owen does, the use of a lighter oil. However, several treatments per season with this grade of oil bring about the same result as may be accomplished with a heavy oil; that is to say, the lighter product volatilizes somewhat, leaving a residuum which, in time, gives a surface equal to that obtained by the use of a heavier oil.

The road problem has assumed such importance that the question of first cost should, to a large degree, be eliminated. The question should be not how cheap but how well the road or pavement may be built to meet the traffic requirements. With this determined, and after the completion of the work, the inauguration of a system of patrolmen constantly on the lookout for water holes and depressions, and equipped to make repairs promptly, is necessary. With such an organization and the annual application to the road surface of a light treatment of oil and sharp sand, the cost of maintenance will be reduced to a minimum. This cost should not exceed from one to three

cents per square yard per annum. Under these conditions the maintenance problem will not assume the usual large proportions.

MR. ROSS: I believe these papers are the most valuable papers I have heard, and I believe it is a subject in which we are all deeply interested. To properly discuss this subject would take half a day. There are people here who have come a long distance to ascertain what to do in these cases, and I move that we adjourn now, take a recess, and take up the subject after dinner at two o'clock.

CHAIRMAN OWEN: We will now adjourn until two o'clock.

NINTH SESSION

Friday Afternoon, November 17

CHAIRMAN OWEN: Now, gentlemen, I think we had better open this meeting, and I do not know but what we had better call it an "experience meeting." I think the first suggestion I would make to the gathering is that those who desire information kindly ask questions on the different propositions in this road maintenance question. I do not suppose that because you get up and ask questions, you will be considered ignorant, as I think all of us are ignorant on certain phases of our work, and I think every man should ask questions of those who have read papers, or of others. So, we will open the meeting by the question box.

MR. BLAIR: I suppose that means to ask questions or discuss the papers, or say anything in relation to the subject, since it is now open to discussion?

CHAIRMAN OWEN: Surely.

MR. BLAIR: I very much regret that Mr. Travilla is not here, as I want to make some strong objection to some things contained in his paper. It was read just before recess was taken for lunch.

It is more to attack the inference or inferences to be drawn from what he did say, than with an idea of disputing anything that was directly stated that I will speak. I was in St. Louis and went over the streets there with Mr. Travilla on last Saturday morning. I have been acquainted with the conditions in St. Louis for the last thirty-five years, and intimately acquainted with them longer, perhaps, than has Mr. Travilla himself. There are brick streets there, or

at least portions of brick streets, that instead of lasting ten or fifteen years, have not had a single item of repair upon them for twenty years.

I agree with Mr. Travilla that St. Louis has the heaviest traffic of any city in the world. That is, the loads are among the largest. But take the downtown portions of Fifteenth street, Sixteenth street, Seventeenth or Eighteenth street which have been subjected to that heavy wear, and it will be found that they have not had a penny of repair placed upon them. That there are some brick streets that needed repairs in the time mentioned by Mr. Travilla is true, but it was because of the manner and method of construction.

Now, I saw this kind of construction going on in the streets there last Saturday: A concrete foundation was being placed, which contained stone that would not pass through a six-inch screen, and some even coarser than that. Of all the foundations I saw in St. Louis, there was not a single one being placed for brick, of which it was possible to make a smooth foundation for a brick street. And if we expect to have any kind of a street at its best, there must be skill in its construction.

Mr. Travilla said he would recommend, if he had his way, and he probably will have in St. Louis, that the cement filler be made, I think he said in his paper, one to three. That is what he told me himself. The trouble with the brick streets Mr. Travilla is putting in now and with the cement filler he is using is not that they are of too good a quality, but rather that they are of too poor quality. After being shown some of the streets that Mr. Travilla was satisfied with, I said to him: "You have not shown me a brick street that you should be proud of, but rather that you should be ashamed of." There were places in the streets, perhaps a square yard or two square yards in area, or even larger, where the cement bond was shattered or broken. Now, if you undertake to put any kind of cement work in a street, you must have the proportions, whatever they are, uniform throughout the entire street You must not have one to five in one place and one to twelve in another. That is the case in the cement streets of St. Louis. They are all checked and broken up. If you put a cement filler in place, in proportion of one to one, it would have a uniform compression, and would not have

those breaks. But you could look down the street for one-half or three-quarters of a mile, and not be able to detect a single shatter in the brick pavement.

There is another question that is raised at this time, and that is, the proper supervision to see that the thing is done right, and if that comes from the city engineer, he must have power enough to enforce his knowledge. In St. Louis, I saw you could not get a good job. As I passed along the streets, someone haled the commissioner, and he went over. What did he find? He found there was a grocery wagon standing in front of a store at the intersection of a street, and the grocer would not take the wagon out of the way. In fact, he had three wagons, and he would not budge them. One wagon was right where the contractor should have had space to deposit his broken stone. If I had been an engineer of the city I would have jerked those wagons out of there in a hurry and told the contractor to occupy the position he was entitled to.

On the other side of the street there was a fellow interfering and kicking about the smoke, and the contractor could not place his engine where it should be placed to permit him to build the street economically. A little further along there was a kicker against other things necessary for the contractor to have in order to build the street economically.

Now, no contractor or engineer can build a street that is controlled by a mob of property owners fighting for the destruction of the very thing which they will complain of afterward if it is not right.

There was another thing that developed there that was remarkable, to my mind, and that was that the stone that was taken up and used for the concrete was pounded by hand. It was coarse, as I have stated, and I said, "Why isn't this stone shot through a mill and reduced to the proper size for this concrete?" The reply was, "The people will not stand for it, and the price will be too high if it is hauled to a crusher and broken as it should be." So, in the city of St. Louis there are thousands of dollars being sacrificed to the whims of people who know nothing about street building.

I think the influence of this association should go out in that direction, and see if it cannot bring about conditions such that streets can be built as they should be built.

I criticise the conditions under which these streets were built; I criticise them as they were built; and I absolutely dispute the fairness of the statement that these streets wear out so early, when they are built properly. (Applause.)

CHAIRMAN OWEN: Gentlemen, while we are on this question of brick—and Mr. Blair is a prophet on it— I would like to ask him one or two questions.

The first question I am going to ask him is this: What space does Mr. Blair in practice consider to be the most desirable for his brick to be laid? We all understand that we are advocating cement grouting for the covering of brick, and I have been troubled about the space between the bricks necessary to get a good clinch. You know in our wooden houses if the laths are too close together you cannot get a good clinch, and if they are too far apart you do not get a good joint, and it is the same with cement grouting for brick.

The other question is how to preserve the grouting on the surface of either brick or stone. In one case we grouted the street, shut off the travel, and the funniest thing I know of happened. The children broke it all up, and we had to cover the grouting all up again with a coating of sand to keep the surface uniform.

MR. BLAIR: First, about the clinch. As to that, there are splendid brick streets in this country where there is no lug or anything on the bricks to separate them. They were simply wire cut. We find that sand and cement can be applied in a thin layer. We agree that that is possible and streets have been so laid that are twenty years old, and you cannot tell anything about their age.

I refer in answer to that question to one single street. Professor Baker in his work "Roads and Pavements," which he prepared nine years ago, mentioned a street in which he said that the wear on the brick was from one thirty-second of an inch to one sixty-fourth of an inch. That street was a wire cut brick street. It was then in its eleventh year, and that was ten years ago. Last year, when nine more years had elapsed, Professor Baker went to that street with a number of prominent engineers, and this question was put to him: "Professor Baker, what is the difference between that street now and the street you wrote about in your book nine years ago, when you said the wear

was from one thirty-second of an inch to one sixty-fourth of an inch?" He said: "I cannot distinguish any difference."

A good many contractors claimed that it was too difficult to get the cement filler down so as to obtain a good clinch if the brick were too close, so the manufacturers put lugs on the brick. That is the requirement in the city of Cleveland today. We have a lug one-eighth or one-sixteenth of an inch out from the bricks so as to hold them. The difficulty is that it is not always uniform, but it gives a separation that eliminates the hazard. As to the limit of that lug, it is immaterial, as there are many places where the cement filler is put in, some joints a little thicker and some a little thinner, and there is absolutely no chipping of the brick.

There should be no chipping in a properly constructed brick street. So I do not see that there is any rule whatever that is vital to the life of the street, as to whether the spaces between brick are one-quarter or one-sixteenth of an inch. The chief thing is to get a cement filler in proper proportion, and that proportion should be one to one.

What was the other question?

CHAIRMAN OWEN: The question of the preservation of the grouting in construction, to keep it from being disturbed before final setting.

MR. BLAIR: Mr. Owen said they had to put a layer of sand over the street. That has to be done anyhow. Why? Because his grouting takes place for the most part in the summer time, and to prevent the rapid setting of the cement it is necessary to put a little film of one-quarter or one-half of an inch of sand over the surface of that street as soon as the filler has been put in. The better practice is to keep it wetted down for a few days, so that it may set slowly and properly.

Now, Mr. Travilla said it cost so much to repair a brick street. I think that was the best thing he said in the whole paper. I think that is the best thing to say about a brick street, for when you break in a brick street you must go into it with a sledge hammer and it should be put back properly, as it can easily be done.

MR. HOOKER: I would like to inquire if you consider one to one as being an absolute limit to which you will put a properly mixed cement?

MR. BLAIR: I do not know, but the best way to answer that question, Mr. Hooker, is this, that in all my experience, East and West, I never have seen a failure of a brick street where that rule has obtained.

Now, you take the brick streets east of the Allegheny mountains, and there are many cities where they are properly mixed. Mr. Cairns, City Engineer of Waterbury, Ct., a most practical man, has not had a square foot of failure in brick streets in his city because of his great care in putting in cement filler, one to one.

The engineer of Ft. Wayne, Indiana, a careful and practical engineer, insisted that one to one was too rich, and he put it in his streets for several years, one to three, with the utmost care. But he has changed to the one to one. After having visited Grand Rapids, Michigan, and seeing what they were doing, and seeing places like Lebanon, Ind., and Paris, Ill., and a number of smaller cities in that locality and in southern Michigan, where they have adhered to the one to one filler, this engineer has concluded beyond all question that one to one is best. I may say that after a very careful examination of Terre Haute, Indianapolis, Columbus and Cleveland by a large committee of engineers, it was absolutely the unanimous opinion of them all that the one to one filler was the thing for brick streets. We know it gives extraordinary strength, and we know that the one to one filler will hold a wonderful expansive force in compression. We know that every engineer in this country who has made experiments in cement will concede that at once. So all the findings we have, both from observation and experience, point to that as the proper mixture.

MR. HOOKER: Isn't your cement, one to one, stronger than your brick, and won't your brick give first, if you have your filler one to one? Whenever there were certain parts of a road where we put one to two, we did not have the same cracks we had where it was one to one. Your cement, I contend, was stronger than the bricks, and so any expansion must crack the bricks first.

MR. BLAIR: That conclusion was drawn by you gentlemen at one time, and I thought and still think you did not have enough evidence to sustain your conclusion. I think it may be well for this convention to know, no matter whether you are interested in brick or stone or asphalt pavements, that the Congress of the United States, at the

strong and continual insistence of the American Mining Engineers, of the National Brick Manufacturers' Association, as well as the National Association of Paving Brick Manufacturers, has finally established a Bureau of Standards. And they are at last at work, after the steel and structural iron people captured their services for most of the year since the establishment of the bureau, now ready to measure with the most exact instruments, all of the forces that cause the destruction of pavements. I believe that at the end of a year or two all those interested will receive helpful information relative to these stresses and strains about which we know little today.

CHAIRMAN OWEN: Now, gentlemen, I think if there is no other question to be asked of Mr. Blair, and no other demand for information on this question of permanent pavements, that we might now go on to the discussion of the question of maintenance of country roads.

MR. McEVOY: Is not the contractor likely to get some soft and some hard brick, mixed, with a shipment, and does that not result in holes in the pavement—holes that are apt to get larger in time?

MR. BLAIR: That is true. The soft brick is the one to fear. The hard brick is a thing to which I do not object.

The National Association of Paving Brick Manufacturers has standardized a machine, but the machine exhibited in the anteroom is a machine for testing brick. We test the brick by that method, and then by means of the information which we obtain from the data, reject the soft brick. The American Society of Municipal Improvements, at its last meeting, established a standard by which the quality of brick may be determined. Their specifications call for 28 per cent. for light traffic, 26 per cent. for medium traffic, and 22 per cent. for heavy traffic. The inexpert person who does not know how to inspect the brick is apt to reject the good ones. In these magnificent roads constructed by Mr. Hooker in western New York—those which he will and should be proud of, as they will last as long as he lives—I felt they had rejected many they should not, and in some cases they rejected a better class than some they accepted. But I told our manufacturers that if they should suffer a little from that proposition they could afford it, because they were having such good roads constructed that the little hardship for the cause of good roads would insure an ex-

ample that would be followed in the building of unlimited mileage as people came to understand their merits.

A DELEGATE: Four years ago I was on a brick pavement and there were eight or nine spots on a street 1,400 feet long where the filler had come out. I want to know whether all those bricks were too soft or too hard, or did one or two fail and the rest follow suit? I own fifty per cent. of the property at this place, and I made the grout one to two, and found the whole street in good condition, with the exception of these spots and a few cracks. But there were spots which had worn out. There were eight different tests, I think, and every one of them showed up well.

CHAIRMAN OWEN: I want to congratulate Mr. Blair, and I can remember that his experience was the general experience elsewhere. In a kiln of bricks, the selection is the whole thing—some are too hard and some are too soft. It is up to the manufacturers to select the class of bricks that are constant and uniform. And Mr. Blair, I believe, will agree with me that in the last ten years, they have eliminated, to a large extent, all these little questions of defects.

I think we have discussed this question of hard brick pavements sufficiently, and I would rather like to raise a question of privilege.

This is a convention held in New York state. We have been somewhat saturated with New York practice, New York experience, and to a limited extent, New York failures. Now, this association extends beyond the limits of New York, and I have in mind the states that are progressing in the road movement, and also cultivating the point which Mr. Lyon alluded to very strongly. That is the question of taking the natural resources of any district and making a good road with them. We have a delegation of enthusiastic men here from Michigan, and we have heard their specimens of vocal development at times, as they sang or shouted their chorus, and I would like to call on Mr. Earle, former highway commissioner of Michigan, to tell us about the development of highways in his state. It has been the most enthusiastic state in the Union in trying to do what they can in this field. So if you will allow me, I will call on Mr. Earle to talk to you.

H. S. EARLE (Detroit, Mich.): Mr. Chairman, I pre-

sume a young doctor would be proud to be called in to remove an appendix that some old doctor had killed. But I cannot say that I appreciate very much the opportunity to talk to an appendix of an audience, as I have been doctoring roads too long to care to doctor an appendix.

You have heard us give our Michigan yell. I will have you to understand that that does not mean a sleepy yawning individual's hi-ho-hum. Our chorus is "High-Hoe-Hum: Good Roads for Michigan! By Gum!" Now that "High-Hoe-Hum" stands for something. "High" is for high aspirations in Michigan; "Hoe" is for the hoe that will cultivate every road; "Hum," a hum that will make the industries of Michigan hum; and "Good roads for Michigan, By Gum!" means we will build a road from each town to the other, by gum!

Now, sir, Michigan has sent the largest delegation to this convention that has been sent from any state in the Union, and at this late hour of the day and of the convention, to you I say that I thank you for your courtesy in asking a Michigan man to speak; but I must decline because I have the best reasons to do so. And if your convention at this state of its existence should care to hear from some engineers from Michigan, I would refer you to the fact that the Chief Engineer of Wayne County, in which I live, is here, and he has $3,100,000 to expend in that one county. He is not building roads that cost one-tenth of the cost of construction to keep in repair, and this is not the condition we are in or ever will be in. We, of Michigan, are trying to get the money into the roads instead of into the pockets of anyone, and we will continue on that same line.

We have another engineer, from Ottawa county, who has had experience with the penetration process. We have the engineer here who built the experimental roads at Ithaca. And I want to say to the members of this convention that no report is put in on the sample roads built at Columbus, Ohio. Seventeen samples were built there. What is the condition of those roads, and why has not a report of them come in? I am not satisfied with the workings of this convention. I express no taffy, I have no barrels of molasses. Twenty-seven of us came here to get some information. I do not like a tongue that is tied. I want that tongue to tell the truth without fear of favor of any interest, and so

if you care to ask Mr. Dingman, Chief Engineer of Wayne county, and Mr. Carpenter, of Ottawa county, and our Mr. Martin, who built the Ithaca roads, they will talk to you about our roads.

I thank you for this minute. (Applause.)

CHAIRMAN OWEN: We will call on Mr. Dingman.

GEO. A. DINGMAN (County Engineer, Wayne Co., Mich.): Mr. Chairman, I am a little bit hoarse on account of holding up the honor of Michigan and letting you know that she is still one of the states of the Union. Some of them were afraid to let you know that we are alive, but we are still alive. And my good friend from Alabama has a little of that spirit in him, as we found the same sentiments on his part, and if the Oklahoma man is here, he has enough for the whole multitude, and if you could hear what he has to say, it would be something more than stands on the map about the new state.

CHAIRMAN OWEN: A question that is important to this association, is that which Mr. Lyon touched upon. He said there were 60,000 miles of roads in the state of New York which could not be improved except by using the material near them, the local material. I understand that in southern and northern Michigan you have the same problem of getting material to your roads. The question is how to take existing dirt roads and highways, and utilize them for the travel upon them, without any of these "high-toned" constructions.

MR. DINGMAN: I will not be able to give you the beginning of the good roads movement in Wayne county. The county road was inaugurated before I came there, but the actual work was not started until the year 1908.

The materials we have to work with in Wayne county are limestone, quarried from the quarries in Sibley and Gibraltar, and what is being brought from Livingston county, and the neighboring county of Monroe; and in the northwest corner we have deposits of gravel which is used on the roads near by, but the pits of gravel are remote from the railroad, so we have to ship in gravel from outside counties for our own gravel roads. Little has been done with the earth roads by the county roads commission on account of the advisability of not taking over any roads except those which are immediately improved by them from year to year. Townships are the custodians, as they

have been in the past, of all roads except those which I have mentioned.

Now, from year to year, the commissioners take over certain portions of road through the action of the board of supervisors in appropriating the money to be used, and indicate the roads to be improved, and the material to be used.

Our first year's work in 1908 was on the water bound macadam, with the painting method, employing tar and stone chips. We used field cobbles shipped in from outside our own county, as we have no stone in our county which is being utilized for roads.

We are using the chips from the stones made for the No. 1 and the No. 2 courses, and it has not proved very satisfactory owing to the high crown which has been maintained by the state in order that the engineers may conform to the state specifications.

After the roads had been down about five months, we began to see that the travel upon them demanded some change in the crown. The engineers thought we should make something stronger to bond up the stone used in the roads, so we incorporated cement, and since 1908 we have been building concrete roads mostly; in 1909 we put down some macadam on roads which did not have to take care of so much travel as the others; we built them with flatter crowns.

I noticed yesterday among your roads one made two or three years ago which had a very high crown. Last year and this year you have adopted a flatter crown, giving the traffic an opportunity to travel over the whole top of the road and resulting in a minimum cost for maintenance. The concrete road as built in Wayne county is not new in this country. While I was engaged in other work for the United States government, I saw that concrete, in my mind, would be a great factor in the building of roads which would withstand the greatest travel of vehicles of any description that might come upon them. Because of this I worked with the county board, and through correspondence with other cities that have built concrete pavements for some time, we concluded to use concrete for our roads. We have a road which has been down for three years on which I don't believe $100 has been spent for repairs. Such repairs as have been made have been in the expansion

joints put in to provide for temperature changes. We use the same coefficient for concrete as is used for steel.

The first year we put down a two course concrete road, the lower course consisting of 2½:5 limestone concrete and a top layer of 1:2:3 mixture. After that year the engineer advised them that he thought a stronger bond could be secured by using a 1:2:4 mixture and making a one course road. In sidewalks where a top finish is put on you will often find a cleavage between the two different mixtures. It is dried out in one layer before the other is put on.

We have some gravel roads under construction in the outlying districts. One of them is in the northwestern part of the county, and it is being subjected to quite a test, and is responding well. We are building in sections remote from the city. The townships had improved some of the roads and we have been trying to get them connected.

But our main traveled roads start from the city limits and continue toward the county line in every direction, and in 1912 we expect every main traveled road out of Detroit to be completed to the county line. And most of them will be concrete, except those in the first year's work, which were of tar macadam.

You have beautiful macadam roads here, and the only question in my mind is the bonding of the top surface to hold the stone in place while it is being worn. Too much crown confines your traffic to the center of the road.

I will be glad to answer any questions.

I thank you, gentlemen. (Applause.)

CHAIRMAN OWEN: What do they cost?

MR. DINGMAN: Between $12,000 and $16,000 a mile.

CHAIRMAN OWEN: How much a yard?

MR. DINGMAN: From $1.00 to $1.31 a yard, practically. That is for concrete.

CHAIRMAN OWEN: Are these concrete roads dustless?

MR. DINGMAN: They are practically dustless. Automobiles sometimes travel over them at sixty miles an hour. We have a motor patrolman who is a deputy sheriff, and he brings down their speed on those roads to twenty-five miles an hour.

MR. HOOKER: How wide are your roads?

MR. DINGMAN: They range from ten feet to eighteen feet in width.

MR. HOOKER: What is the surface?

MR. DINGMAN: This year and last year we made a concrete of gravel ranging in size from one-quarter of an inch to one and one-half inches; everything below the quarter-inch size we used as sand.

MR. ROSS: Do you find a difference in the wearing qualities between trap rock and limestone?

I am building a gravel road and have no trouble with it.

MR. DINGMAN: We have used no limestone in the upper surface; we have used the limestone in the base, or first course.

MR. BLAIR: But you have abandoned your two to one for one to one and one-half?

MR. DINGMAN: Yes, sir; we use a bank gravel, screened and washed to the sizes which I stated. Our specifications called for washed sand and gravel. We are getting gravel for $1.00 a ton and sand for $0.80 a ton.

MR. PRICE: How is the concrete mixed, by machine or hand? How long are the roads kept closed before the traffic is turned on; and have any figures showing comparisons been sent in?

MR. DINGMAN: Our concrete is all mixed by machine.

We keep our roads closed to traffic about fourteen days in summer time.

What was the other question?

MR. PRICE: Are there any reports relative to the hardness of the surface?

MR. DINGMAN: It has a surface about as hard as brick. Its surface is gritty and not slippery in wet weather. When ice forms on it, it goes off very quickly.

MR. SMITH: I would like to ask whether you use transverse expansion joints; and if so, at what intervals do you put them in?

MR. DINGMAN: We use transverse expansion joints every twenty-five feet, and they are about a quarter of an inch wide. We first used tar paper in them, making plain joints and putting in a few angle irons as an experiment to determine what protection they afford. Last year we made them all of tar paper again. This year we used what is termed the Baker protected joint, which consists of a thin strip of metal, three-eighths of an inch wide on each side of the joint, with asphalt paper between instead of the tar paper. The tar paper we found was losing its life too rapidly, and the asphalt paper would last longer, so we put that in for cushioning.

MR. SMITH: You think metal armor is necessary?

MR. DINGMAN: Where we have put it on it has protected the corners where the joints come together. It must be of soft metal with the same coefficient of wear as the concrete.

MR. MEEKER: In reference to your remark that excessive crown was demanded by the state highway commissioners and was afterward reduced, I would ask, what was the old crown, and what crown are you now using on your streets?

MR. DINGMAN: The state specifications now call, I believe, for the flatter crown. Formerly it was one inch to the foot, the contour to be a parabola. During the second year we reduced it to one-half an inch to the foot—that is, on macadamized roads. On our concrete roads we used one-quarter of an inch to a foot, and have obtained good results.

MR. ROCKWOOD: After you finish your concrete, do you cover it with sand so that it will not dry and set?

MR. DINGMAN: We do. We cover it with one inch of material that we get on the side of the road—anything to protect it; and then we keep it wet down for seven days.

MR. ROCKWOOD: In many portions of this state it is hard to build concrete on account of lack of water.

MR. DINGMAN: We are using a system of water works. We have a gasoline engine and we force water over long distances under 80 pounds pressure.

MR. ROCKWOOD: I had to push water four miles this summer.

MR. ROSS: Is a motion in order, Mr. Chairman?

THE CHAIRMAN: I can tell better after you make it.

MR. ROSS: I wanted to suggest that Col. Sohier, Chairman of the State Highway Commission of Massachusetts, is here. I do not want to claim anything special for Massachusetts, but I know he has to go away rather early, and with your permission, I would like to have him make a few remarks before he leaves.

CHAIRMAN OWEN: We will be pleased to hear from Col. Sohier.

COL. SOHIER: I thought of one thing that I would like to say relating to the question of maintenance and construction, about which some of the states have something to learn, and possibly might learn it from our experience in New England.

It seems to me, Mr. Chairman, that this association should try to see whether it believes that engineers or road builders, or whatever they choose to call them, to educate whom states have put out a lot of money, should be kept in place and use the education which they have been given so that the people in the state who pay for that education may obtain the benefit of it. I like all the people I have seen from New York, but I have been on the Highway Commission in Massachusetts only since 1908, and I have already taken four sets of New York commissioners over our Massachusetts roads, each set having a different idea of how a road should be built, and each spending from $5,000,000 to $22,000,000 a year for roads that the people of the state of New York pay for. And I have seen those roads disappear, some of them, like ships in the night, as they were built of six-inch macadam on top of blue clay, and the next spring the clay was on top.

We came here with eight people from the Massachusetts Highway Commission—two division engineers, and one gentleman who keeps the accounts in the office, and another who is chief engineer in the office, drawing plans, and our chief engineer whom we took from New Hampshire, and every one of them had been building roads with some commission for fourteen or fifteen years; and when I was appointed I had been building roads for twenty-two years on the north shore, building roads by subscription.

I think that is one great trouble with your road builders today—they are not retained in office after they have become experienced.

In Massachusetts we have many towns that change their superintendents about the time they have learned something at the expense of the public. We have many cities and towns where the only men employed are old men, who are employed to keep them out of the poorhouse and they receive $2 or $2.25 a day for labor, while they can earn only about seventy-five cents as compared with anybody who can really shovel dirt. Efficient labor and organization I believe are more important in road building than anything else.

The gentlemen here have not talked actual road building. They have said "You want to secure a good foundation," but they have not told you how to do it.

We have in our employ about fifty men who have had

four years', or five years' or six years' experience, and they have someone over them with fourteen or fifteen years' experience; and if we are to lay out a road, they dig holes in it, and if they have clay along the line of that road, they should find it, and they should specify how a road is to be built under such conditions, where foundation is needed and where it is not. We have roads built fourteen years ago where we have done nothing to maintain them but apply a coat of asphaltic oil or tar, applied hot.

We have met failures with heavy asphaltic oils. We failed three years ago on every kind of oil which we used except from one concern, in trying to make a coating that would stand wear for more than one season. They rutted, they rolled, and they got ridges on one side. The road was like putty.

We analyze about 700 samples of tars and oils per year, but we do not know what we are analyzing. We have had our failures with tar.

When Mr. Dean was talking this morning, I thought some of your would think we had not succeeded with heavy oil. We have succeeded with it on 300 miles of old road, and we failed on only three or four miles out of the 300. In two instances it was due to the fact that there were about 150 loaded ice teams carrying from three to four tons each, which tore the oil up or wore it out, and the road was worn out first on the right side, where they went loaded, and in a very few days; while it stood two months longer on the other side where the wagons returned light.

We have something like seventy-five miles of roads that were treated three years ago, and some of it cost $20 a mile for patching, next year, making the fourth season. This was, of course, where the best material was used.

Now, another thing that may be of interest. On the road which failed with the heavy oil, we applied this year a coat of light oil, about a thirty per cent. oil—which probably, in reality, is about 17½ per cent. When we put the light oil on we got about the same result as if we had put on a heavy cold oil, and it lasted well through the season. We find if we put an excess of heavy oil on a road—for instance, two half-gallon coats—it will begin to rut and roll the next year, and it is hard to keep it smooth and even.

We are maintaining gravel roads with oil in Massachusetts, where there is a good deal of automobile traffic.

We took a traffic census at 256 stations on the state highways in Massachusetts for fourteen hours a day, seven days a week, in two different months, and we got some information so that we could tell what our traffic actually was. We found only fifty-one automobiles on some roads, while on others there were as many as 3,000, and loaded teams varied from 27 a day to 700. So you see your traffic conditions vary, and you must build roads for your traffic.

We found on our gravel roads that we could use a heavy cold oil and save those roads even with high speed automobile travel. That is not a guess, as I have done it for eight years on some of the roads in Beverly. You get your troubles on them. Of course an oiled gravel road will not stand up as well as macadam that is built at three or four times the cost, but will with light team traffic and will make a reasonably good and satisfactory road for automobiles, and at a small cost. The oiling on these gravel roads with a heavy cold oil cost from 4 to 5 cents a square yard. Next year I expect to have nothing to do to these roads but the patching. And I might say we have quite a number of horse-drawn vehicles going on them, but not many loaded teams. Often 500 automobiles gather in a day.

In some places these roads are cut into mounds and ruts. I thought it was the oil that made them until I dug holes in it, and then I found that my theory was different on the road from what it was in the office. I found that the ruts came in certain places that had no foundation and the gravel could not carry the load. The oil was as thick on the bottom of the rut as on the top of the soil. I found the ruts were mostly made by an iceman who made four trips a day with a six-ton load, and, of course, always in the same rut. To keep him out of the rut we put some stones in it, and those caused all the motor vehicles to turn out of it. That method of preventing ruts is not original. It was adopted in Versailles, France. They put three cobblestones in a rut, one on top, and the top one is painted white. The vehicles all turn out and after a time they move the stones around on different parts of the road which show signs of wear, compelling the traffic to use all of the road surface.

The main thing, after all, is to get people that know something about road building, keep them and send only

competent men out on the road. You can get a foundation then, where it is needed and not where it is not. Now while New York is spending $22,000,000 this year, and $50,000,000 in all, Massachusetts will have spent only $8,000,000 on state highway construction in seventeen years, and we think we can come as near giving you as good a road in western Massachusetts as you will find in New York state when their roads will be five or six years old and many of our roads will be over ten years old.

When one of the gentlemen stated that you can build a road by eye and you don't need engineers and surveys, I would say that you may be able to do it in some places. But go on Florida mountain in Massachusetts, where the present road has sometimes eighteen per cent. grades and is all side hill work and rock and very expensive construction. Our engineers have found a new line over that mountain that will cut off considerable distance, will have not more than a seven per cent. grade and where a road can be constructed for less than half the cost per mile of the cost of building on the old route. Perhaps some fellow can find that grade with his eye, but he certainly would need an eye that could see around corners and through forests and hills.

CHAIRMAN OWEN: I have had one position for forty-two years, and I am not in favor of a change. I believe in keeping the man that gets experience in any locality.

COL. STEVENS: I would like to ask the gentleman two questions: First, what binder he used on his gravel; and, second, how the oil is put on?

COL. SOHIER: I use the heaviest cold oil that I can. We shape and patch gravel or macadam roads carefully before we put on any oil, we brush them clean so there is no dust, fill every depression, then spread our oil on it, today, under pressure. Then we keep that covered with gravel or stone chips and dust or sand for two or three weeks so that no oil appears upon the surface or can be carried off on wheels.

A DELEGATE: In the South we have a great deal of clayey gravel that makes excellent roads, the clay makes a binder for the water worn gravel; but they become dusty, and the question of putting oil on the roads, especially in Alabama, has been suggested a great deal.

COL. SOHIER: Could you use sand for covering?

A DELEGATE: In some sections we could.

COL. SOHIER: The California specifications and the report from Mr. Ellery and Mr. Fletcher say that you cannot make a thick section with oil if there is more than twenty per cent. of clay. With twenty per cent. of clay you can; so I would try a light oil and let it consolidate from year to year.

COL. STEVENS: Do you allude to the sand and oil roads on Cape Cod?

COL. SOHIER: No, sir.

COL. STEVENS: How are those succeeding?

COL. SOHIER: I think very well for the cost. They are costing $2,500 to $3,500 a mile, depending on the kind of method you use with your oil and sand. The mixing method may be $3,000 or $3,500. If you use the cultivating method you must use it for two or three years. The first year you may build for $1,700 or $1,800 a mile a road fifteen feet wide. The next year you must harrow it over again thoroughly and find the weak places, add more oil where needed and roll it back in shape. I think we are doing better with pressure distributors, and I think we are getting free from many of our troubles. These roads are good for the money, and in many places on Cape Cod macadam roads would cost so much that you could not built them.

COL. STEVENS: You say that the clay cannot be used as a base on an oil road?

COL. SOHIER: Yes, sir. I understand that is the California experience.

COL. STEVENS: It may be of interest to the gentleman from the South to know that in New Jersey we have a "road gravel" that is composed of pebbles, sand and clay. In the old days, before the advent of the automobiles the roads built of this gravel in Monmouth and Cumberland counties were some of the best roads in the state.

In other words, it is our present opinion—and I will state it only that way, as I do not consider it a demonstrated fact—that the use of light oil on gravel roads is almost certain to result in failure. We are now trying Glutrin as a dust preventive, and not a dust layer. It promises to make a more stable road for winter and one less likely to have surface mud. We are also trying an experiment with Trinidad Lake asphalt oil. It has been put on a gravel road leading to Atlantic City very much after the method by

which it is applied on the Massachusetts roads—one-half a gallon to a square yard, and three-quarters of an inch of sand.

I derived that formula, I may say, from the information I received from the Massachusetts office. I inspected the road last week, but it has just been laid, and it has not been subjected to sufficient traffic to determine its value.

The question is whether the bond between the covering and the underlying gravel will be strong enough to resist the effects of automobile traffic at high speed on such roads. On our present gravel roads it peels off.

COL. SOHIER: Is the gentleman sure he used an asphaltic oil?

COL. STEVENS: The other roads have been built with Standard oil. The trouble seems to be that the distribution through the gravel is uneven. The oil goes out into pockets. The state of New Jersey has been trying some experiments with the local materials found in different portions of the state in attempts to build roads at an economical price. Those experiments have not progressed far enough for a definite report.

On one road we are using a gravel that carries an insufficient amount of clay for bonding, but it is not a material that you could use for concrete. We have a large amount of such material throughout the state. It makes a sandy road, and a road that becomes somewhat muddy in winter.

One curious fact was noted in regard to the effect of watering the top course. We could not penetrate the material when it was dry. If moist we could penetrate it. It was rather upsetting to my previous ideas. The road has broken up in places, but the majority of the surface is giving fair results.

I do not regard it as more than an experiment. I trust, however, that in future, we may have something definite to report.

MR. ROSS: We have oiled sixty miles of streets and we have had the same trouble. Take a road with dust and clay on the surface, and soak it with water this afternoon and then tomorrow morning put on the oil or tar and it will adhere, but put it on when it is dry and it will seperate and roll up on the vehicle wheels.

CHAIRMAN OWEN: I would like now to hear from the state of Alabama. I know that in Alabama they have been doing good work.

COL. NELSON: I am an enthusiast on road building in Alabama, and I am as full of the science of road building as one of my neighbors. I will tell you about him.

Last winter one of my neighbors had taken more than was good for him, and he came in one day and he told the negroes there, "Now, boys, we must raise scientific crops this year. Under the old system we have been raising only one-half what we should get." Then he started in with the negro boy who builds his fire. Now, every Alabama nigger can beat the world building fires; so he told him to put those shavings on top, that that was the scientific way to build fires. He came down the next morning and Jake had a good fire. He said, "Jake, I see you are building it scientifically?" "Yes, boss," Jake said, "scientific like you told me, but I put some common sense under it."

And that is my way with road building. I do not know a thing about it myself, but if you want to know about it from the scientific point of view, our state engineer is here, and if he cannot strike oil in ten minutes, I will give it up.

CHAIRMAN OWEN: We will hear from the State Engineer of Alabama, Mr. W. S. Keller.

W. S. KELLER (State Highway Engineer of Alabama): My work in Alabama is more of the educational kind. We perhaps have the youngest highway department in the United States, so our work is rather to educate our people preparatory to taking up active road construction in the state. Our legislature made an appropriation of $2,000 for each county in the state, provided the county would put up a like amount to build a road under specifications and under the direction of the county engineers. Many counties take advantage of that.

We are building a short section to demonstrate the proper method of constructing roads out of the local material. I preach all over the state of Alabama that if it is possible for roads to be constructed out of materials at hand, to do so, because the maintenance is cheaper than if you have to ship in from year to year.

There is another phase of our educational work, and that is to convince the farmer that a public road is a part of his property; that he, above all others in the state, is directly interested in the up-keep of that road; that the road is as much an asset of his farm as his barn and his

house, and that if the road goes down, his property depreciates just as much as if his barn fell.

You of the East have no conception of what an educational campaign means in the South, and what a set of people, absolutely ignorant of what a road is, we have, and the difficulty of convincing them that though the road will cost money, it will pay to build it.

Monroe county asked for aid in the regular manner and filled out the blanks. I sent my assistant to that county to let him interview the officials and ascertain what they were asking for, and if they were prepared for us to build them a section of road. When he got there the probate judge—he is ex-officio chairman of the board of commissioners—said, "Mr. Boyd, we are glad to see you here; I hope you have $2,000. We have $2,000, and we want you to put all our roads in good repair."

He remarked to him, "Judge, you haven't read the law. We are to build you a piece of road out of local material you have here." The Judge looked at my assistant hard and said, "Do you mean to tell me you are going to spend $4,000 on one road?" He responded, "No, sir; on one piece of road." (Laughter.)

Now I will tell you of another county, as I think this shows more than anything the personal interest taken in roads. In Lauderdale county the commissioners built without aid. I went there myself, and they had everything in form, machinery and everything, to build a good piece of road. Their only question was where they would put the $4,000. The law says that the county commissioner shall select a road to be improved, and there were four commissioners, and there were four different directions for this road to go. As they were discussing the matter, one farmer said, "I will give twenty days' work with my team if you put it in my line." And another would offer something else.

So they said, "We will open bids on the 14th day of October. We will receive proposals." And what is known as the Waterloo road came up with sealed proposals, guaranteed by a man of means, offering in cash and team hire, $5,570, to get that $4,000 of appropriation. Now, I say this: Those people are putting their money and their muscle into the construction of that road. I do not believe for a moment they will ever allow that road to go to pieces.

So, we educate our people who are interested in the roads. Our problem is to make the user of the road interested in the building and maintenance of that road.

I thank you very much, gentlemen. (Applause.)

CHAIRMAN OWEN: This meeting is now open to promiscuous discussion. There are many questions that might be asked by different members interested in the road business which might solve problems.

MR. ROCKWOOD: I would like to ask Col. Sohier whether they do not have analytical tests of their asphalt?

COL. SOHIER: We have analyzed 350 specimens of all the stuff we have used for the last three years—about 350 analyses a year, and I was talking of what the chemists found, and not what was said to be in it.

MR. ROCKWOOD: It comes in sealed cars and cannot be used until the seal is broken by the engineer and the stuff approved.

COL. SOHIER: I think we had asphaltic oil that melted at 280°, and then when heated for twenty-four hours there would be residuum of some earth or carbon and other material. Therefore, the real asphalt or hydrocarbon in a heavy oil does not exceed that ninety per cent. Possibly it is sixty per cent.

MR. HOOKER: Will the gentleman tell just what asphalt is?

COL. SOHIER: I will have to refer him to Mr. Hubbard's book, where the gentleman will see the different kinds and the chemical formulae.

CHAIRMAN OWEN: The Chair would like to interpolate a particular proposition: I had a gentleman who was very solicitous about having standard tests made for asphalt and other road oils, and I told him that when we know what material we want, and have it established as a good practical working medium for road construction, then we should have that tested, and have the test established as a standard to which the material should conform. Till we get to that point I am suspicious of any chemical analysis I have ever had.

MR. FRIEDRICH: Does the gentleman believe in sheet asphalt for state roads, or concrete asphalt?

CHAIRMAN OWEN: Sheet asphalt is a stereotyped practice, and the concrete asphalt is something different. Do you mean asphalt mixed with cement?

MR. FRIEDRICH: I mean unfluxed California asphaltic cement.

I think one gentleman did not believe in old macadam roads where there is heavy traffic. I believe in concrete, brick or asphalt. You see there is a road here on which there was a piece of about one mile on which the construction was changed and we put in a section of concrete. We received $1.24 a yard and guaranteed to keep it for five years.

The machine was taken there and a double gang was put on it, and they laid a mile of it in five days and four hours, and they drove over it two hours after it was laid.

As I stated before, I believe in making a good road. The macadam portion of the road is practically going to pieces now after being down one year, while the asphaltic concrete is in as good condition as when laid. We have another contract on which we are using the same material, with a 1½-in. surface course on a 5-in. concrete base. The cost is about $1.60 per square yard. We do not hesitate to guarantee a roadway of that kind for ten years. We believe it will last fifteen years, and there is but one and a half inches of asphalt on the top. We believe a road properly mixed and laid will stay there for a number of years; but it is a question of the holes in your pavement and the necessity for making repairs.

I would like some gentleman who has seen this one mile stretch laid last October to speak on it.

MR. ROSS: I believe we owe a good deal to the different road material manufacturers. I do not think any of us come here with any feeling of trying to build up one and break down another. I think we have all got to relate our experience and hear that of others and then judge for ourselves.

Now a material in use on a street in Massachusetts or a state road in Massachusetts in the western part of the state would be entirely unfit for use on Cape Cod. And it is just so here in the state of New York. You have places here where you have a good gravel foundation, and under those conditions you could use any tar or asphalt. But take a clay foundation, and the conditions are entirely different. You have the action of the frost which will heave up any asphalt and tar in the winter, and any asphalt and tar that can stand that is something that I have not yet seen.

Now, the agents selling these different oils are not fakirs. They sell us a material; it is Asphalt "A," or Asphalt "B," or Asphalt "C," or Tarvia "B," or Tarvia "X," and to the layman it means nothing, but to the engineer or a practical road builder it does and should mean everything, as we have no business to buy except to get good results.

I believe it pays to buy these different materials and try them out. I do not think there is any hard and fast rule as to what to use and what not to use, and so we have no material that is absolutely good under all conditions and in all places. The cost may be prohibitive in some places, and in other places we have got to apply the material according to the money we have. Many towns could get along with these lighter oils and make a practical waterproof road that would not muddy up, at one and one-half cents or two cents a square yard.

My experience in the last twenty years has been that you will get advice from every fellow that come along, and then use your common sense, as the darky boy did in building his fire.

MR. FRIEDRICH: I think it is a good deal the fault of the contractors themselves. Nine-tenths of the contractors are cutting each other's throats, and they cut the prices and they cannot get out. I say if a man gets a good price for his work he can guarantee it. We do not want to put down any of our work unless we can guarantee it. In Rochester we guarantee work for ten years.

A DELEGATE: I want to talk with the gentlemen who have to do with good roads. I have been exceedingly hurt in the last year, and it may be that I don't know anything about work. I have had the county engineer and the road committee and the entire council against me, and I have stood alone. I want to make a statement to you regarding a road on which we built some 1,500 feet. It was built on a fill over marshy land, and for ten years I have seen that road in the spring of the year in such shape that a little loaded truck would sink to the hub. I was put on a council for the purpose of directing some of this work.

The engineer said, "We will dig a trench in this clay road, 16 feet wide and 5 feet deep." We filled the trench with inch and a half macadam; on top we put three-quarters; then they bound that with clay; the spreading was fine and the excavation was level. Then we put on the

water wagon and the ten-ton roller, and parts of the road went down. I do not know what made it go down, but I told them it would, and I was right. There is a soft bottom under that road for three or four feet. We cannot put in a pile driver, it is too expensive. Now, the contractor came back and he tried to fill up the low spots. And after trying, he said to me he could not fill them up, and I told him, "I knew it." They want large trucks carrying iron castings and moving vans of the heaviest kind, traveling over that road. Will somebody tell me what we can do with the road, and whether it was proper—I am here for advice, and I am willing to accept any criticism—to put two-inch macadam on a clay soil without any show of draining it? I said to the contractor, "Aren't you going to subdrain it?" He said, "No, the engineer doesn't want it."

MR. ROSS: You say you had three or four feet of muck?

A DELEGATE: In the summer time it is hard, and in the spring you can go down two or three feet.

MR. ROSS: If it did not cost too much to do it, I would raise the grade.

A DELEGATE: We understand we can dump stone on there.

MR. ROSS: If you have five feet of filling over a clay bottom, and put on a steam roller and roll it down properly, and then put on your roller, it will never spout mud.

A DELEGATE: This is a clay bottom, filled in, and on that clay they have built an eight-inch macadam road—six inches at the side, and crowned to eight inches at the center.

MR. ROSS: That is a different proposition. If you get into that condition it is better to put on good coarse stony gravel. Put one foot on and raise the grade up, and then put a light coat of macadam, six inches, over that, and you will have a good road.

A DELEGATE: Should we have built an eight-inch road on the clay bottom without subdraining? I want to know whether I understood anything, or whether I was a fool. I say, it was not a proper thing to build an eight-inch macadam road on a clay foundation, where you could go down two feet in the spring of the year.

E. A. PATERSON (Port Arthur, Ont.): I came here to learn something, and it is astonishing to me to see these subjects discussed as they are.

I think your convention has been a very great success, and there is little doubt that these meetings will solve road problems later. It is a great mistake to single out a group of substances, without giving all a chance to discuss and place their ideas before the road builders and give their work and experience and experiments, and all that sort of thing.

In this convention I should like to say that a great deal of time has been given to bituminous binders and oils. These are all very good in their way, but there are new scientific questions that come in, and that is the chemical side; and I should like to say that at the next convention, opportunity should be given to people who have materials, and who spend a large amount of thought, to place their views before the people who are looking for information.

We don't come to a convention of this sort singly or as individuals; we come as men set apart by public opinion to come and discuss the question of road building, and I think it is outside of the game to bring up for discussion the materials or advertising. I think we should use our time and our ideas to the advantage of good roads.

I thank you very much for the courtesy I have received in America as a foreigner.

A DELEGATE: I was reading in some of the Consular Reports some years ago about some experiments that the British Government was making on some of the Australian highways, in which there was introduced into the sandy soil, a plant known as the German yellow clover, with the express object of so changing the character of the soil as to make it productive. After reading that I tried it on some roads. We have a portion of from twenty to fifty miles, composed of drifting sand. I tried that, putting the clover mixed with rye on both sides of a strip of roadway twenty feet in width. Then twice a year I cut that and put it on the sandy road, and then covered it with four inches of rye straw. The application of that German yellow clover and the rye straw has so changed the character of the road that now, after three years, it is an automobile speedway.

MR. PATERSON: I am afraid that is "a new one," as you say, on me. But the Australian Government has its agricultural department, as you have here, and I think they have the idea of utilizing the waste space on a road for

some special purpose. I think you have a large amount of road which is practically unproductive, and the question is how to utilize that from the commercial point of view.

In South Australia it was a barren county. They produced five bushels of wheat to the acre, but through the agricultural department they have increased it, by the use of phosphates produced from natural sources, so that they now get fifteen bushels. They now want to utilize the very, very wide roads. Those roads are very wide—they must be wide, for on the largest ranches they have seven, eight, nine and even ten million sheep. In certain seasons of the year, when the animals crop it, it is all right, but after that it becomes a menace to the people through fire.

There is one thing that struck me in this meeting, and that is the very widely differing opinions expressed as to the amount expended on roads. One says, $2,000 to $5,000, and another from Michigan says from $13,000 to $16,000. In the road building business you want some basis of public opinion as to what is the amount which should be expended upon a road as a commercial proposition.

So, after all, road building has a basis to start on and roads can reduce the cost of living by transporting the commodities as cheaply as possible.

I would like some expression of opinion from the commercial men as to what basis a man should work upon to build a suitable road for general conditions.

MR. EARLE: I think the gentleman should know that we are not building that kind of road all over Michigan. That is in Wayne county. There we have a population of 500,000 and an automobile industry that pays $30,000,000. Of the money that builds those roads, the City of Detroit pays 85 cents out of every dollar. The city of Detroit and the village and the county pay 93 cents out of every dollar, leaving only seven cents for the farmers.

That 302 miles of road is largely for the automobile. We have the money and can afford it.

Outside of Wayne county we build gravel roads at an average cost of $1,638 a mile; and macadam roads at an average cost of $4,250 a mile. That is the average cost of the roads outside of Wayne county. We are building those roads in Wayne county with some of your money.

MR. ROBERTS: I think this is the best part of the entire convention, and I think these men will go home and

say they enjoyed this last hour of the convention better than any other.

In the state of Washington, we have many varying conditions. I must say that I take off my hat to those who can grow clover on a roadside and convert a sandy road into an automobile speedway by means of a split log drag, at a cost of $8 a mile. That might be taken as a minimum for our traffic in Walla Walla county, one of the oldest settled portions in the state where the soil is a light volcanic soil in a friable condition. Under favorable conditions, it is the best wheat county in the state, but the farmers are all wealthy and the farms are growing larger with less population, and the cities are getting more densely populated. They have a straw day just after the threshing of the wheat, and the average farmer will haul straw on the road, in front of his farm. This occurs in August. The roads have become so thoroughly pulverized by the narrow tired wagons, that the dust is from four inches to six inches deep. They haul a load of straw and they distribute it, eighteen to twenty feet wide, over a stretch 100 feet long, and after that is settled into the dust, after the rains, it is a good road. They have "puncheon" roads also, and I went into a county where they spread sagebrush over the sand road. We have areas as large as the state of Massachusetts, 8,000 square miles, where there are not 8,000 people—not one to a square mile. So we have all kinds of roads. We also have a city in the state of Washington, which is a little larger than Rochester, and radiating from it, you will find roads costing $10,000 a mile and on top they are putting a hard surface, costing $15,000.

CHAIRMAN OWEN: What is the labor?

MR. ROBERTS: We are limited to eight hours a day, and the minimum wage is $2.50 and I want to say we are working the convicts in the state of Washington, and we never have had a particle of trouble with the labor unions. They are paid as well in Washington as they are paid in California.

And those convicts work in the five different state quarries, fifty in each quarry. We have some free laborers there and some guards and machinery men, and our expert men in quarries are convicts. We have men who are graduates in the arts and sciences, as Mr. Hill said, that can blast down rock cheaper than anybody else. And why?

Because they knew how to use nitro-glycerine. Public opinion is in favor of using more and more convicts on the road.

CHAIRMAN OWEN: It is getting late, and I will call you gentlemen, "The Faithful." You have stayed through the ordeals of discussion, and you are here at the final winding up. I want to congratulate the whole convention, and particularly you gentlemen here.

The registration at this meeting is 1461 (Applause), which I think is the largest registration at any road meeting that has been held in this country. I think you can all point with pride, and go home feeling proud that you were a member of this convention, which has a record for attendance and for some crytallizing of road practice.

I want to say this, gentlemen, that my theory of the road business is that for the last four or five years, it has been absolutely and positively experimental. I think you will all agree with me on that: I have been building roads forty or forty-five years. I had a practice crystallized which was efficient and satisfactory. I had to begin all over again, as a boy, practically, in the new regime of road construction, and our experience in the last four or five years, the details of which have been given at this meeting, has been more conducive to road improvement on this continent than anything which has been done before.

I say that with a strong inward conviction, for I think it is the truth.

I want to congratulate you on the work, and I want to say to you gentlemen who are here, that the road business is a matter of national interest and national importance. It is a matter of economical importance, which comes before all of us in roads and in our home life, and it is up to us to give the best results for the least money. (Applause.)

COL. NELSON: Now, gentlemen, we want you to have the next convention in Alabama, and while I do not know much about road building myself, I do know that this organization is made up of the most eminent road builders in any organization on this globe. And we would like to have you gentlemen hold your meeting at some time and place in our state next year. We want you all to be there; and we also want the citizens of Rochester there.

I have enjoyed myself immensely in Rochester. In Ro-

chester you have as good a section in the Genesee Valley as we have in the Tennessee Valley, of Alabama.

CHAIRMAN OWEN: I want to suggest that Mr. Earle lead us in giving three rousing cheers for Rochester, with the assistance of his trained chorus from Michigan.

(Three cheers for Rochester.)

CHAIRMAN OWEN: A motion to adjourn sine die is in order.

(Motion made, seconded, stated and carried, and the convention adjourned at 5.30 p. m.)

List of Exhibitors

Acme Road Machinery Co., Frankfort, N. Y.
American Asphaltum & Rubber Co., Chicago, Ill.
American Surety Co., New York City, New York.
American Tar Co., Malden, Mass.
Amies Road Co., Philadelphia, Pa.
Atlas Portland Cement Co., New York City, New York.
Bain Wagon Co., Kenosha, Wis.
Barber Asphalt Paving Co., Philadelphia, Pa.
Barrett Manufacturing Co., New York City, N. Y.
Bausch & Lomb Optical Co., Rochester, N. Y.
A. J. Beckley, Garwood, New Jersey.
Bituminized Road Co., Kansas City, Mo.
Bituminous Road Implement Co., Boston, Mass.
Buffalo Pitts Co., Buffalo, New York.
Buffalo Steam Roller Co., Buffalo, New York.
Burch Plow Works Co., Crestline, Ohio.
A. Burlingame Co., Worcester, Mass.
J. I. Case Threshing Machine Co., Milwaukee, Wis.
Columbia Wagon Co., Columbia, Pa.
Dolarway Paving Co., New York City, New York.
Dunn Wire-Cut Lug Brick Co., Conneaut, Ohio.
Eagle Wagon Co., Auburn, New York.
Everett Manufacturing Co., Newark, New Jersey.
Frick Co., Waynesboro, Pa.
Galion Iron Works, Galion, Ohio.
Geiser Manufacturing Co., Waynesboro, Pa.
Glen Wagon Co., Seneca Falls, New York.
"Good Roads," New York City, New York.
Hastings Paving Co., New York City, New York.
Haywood Wagon Co., Newark, New Jersey.
Hetherington & Berner, Indianapolis, Ind.
Huber Manufacturing Co., Marion, Ohio.
International Harvester Co., Chicago, Ill.
International Motor Co., New York City, New York.
Marion Steam Shovel Co., Marion, Ohio.
Henry J. McCoy Co., New York City, New York.
C. H. Morse & Son, Rochester, New York.
Munnsville Plow Co., Munnsville, New York.
National Mixer Co., Rochester, New York.
National Paving Brick Manufacturers' Association, Cleveland, Ohio.

Rocmac Company, Port Arthur, Ont., Canada.
Standard Manufacturing Co., Worcester, Mass.
Standard Oil Co., New York City, New York.
Steel Protected Concrete Co., Philadelphia, Pa.
Sun Company, Philadelphia, Pa.
William P. Tarrant, Saratoga Springs, New York.
Texas Company, New York City, New York.
Thew Automatic Steam Shovel Co., Lorain, Ohio.
Troy Wagon Works Co., Troy, Ohio.
U. S. Wood Preserving Co., New York City, New York.
Universal Portland Cement Co., Chicago, Ill.
Universal Road Machinery Co., Kingston, New York.
Warren Bros. Co., Boston, Mass.
Watson Wagon Co., Canastota, New York.
R. D. Wood & Co., Philadelphia, Pa.

AMERICAN ROAD BUILDERS' ASSOCIATION

Secretary's Report

To the Board of Directors,
American Road Builders' Association.

Dear Sirs:

I have the honor to present a statement of receipts and disbursements of the association for the year ending December 31, for the period from August 26, 1911, to December 31, 1911. I also submit herewith a general balance sheet showing the condition of the affairs of the association:

RECEIPTS.		DISBURSEMENTS.	
Balance on Hand Aug. 26, 1911, as per voucher from retiring Treasurer, J. W. Hunter	$331.43	Telegrams & Telephones	$1.60
Membership dues	160.00	Postage	5.90
Exhibition, Rochester Convention	2,625.00	Convention Expenses:	
List of Delegates	4.50	Clerical Help	100.00
Membership dues in hands of Secretary	76.00	Postage	454.24
		Office Supplies, Telegrams, etc.	30.93
		Stationery	35.85
		Printing & Electrotype	5.93
		Badges	195.94
		Facsimile Letters	19.80
		Decorations	650.75
		Seals	14.85
		Tent	90.00
		Signs	10.00
		Stenographer	112.92
		Typewriting	7.10
			$1,785.81
		Balance on Hand, Hands of Treasurer	$1,335.12
		Membership Dues on Hand	76.00
			$1,411.12
	$3,196.93		$3,196.93

GENERAL BALANCE SHEET

ASSETS		LIABILITIES.	
Cash on Hand, Treasurer	$1,335.12	Printing	$94.75
Membership Dues on Hand	76.00	Facsimile Letters	8.83
Due from Members (billed)	48.00	Postage, Telegrams, Etc.	31.28
Due from exhibitors	225.00	Stationery	19.00
		Convention Expenses:	
		Hotel Headquarters	24.64
		Hotel Stenographer	20.65
		Hotel Assistant	15.45
		Traveling Expenses of Secretary	62.42
		Printing	228.50
			$505.52
		Surplus	1,178.60
	$1,684.12		$1,684.12

New York, January 2, 1912.

(Signed) E. L. POWERS,
Secretary.

Treasurer's Report

To the American Road Builders' Association:

Gentlemen: As required by Section 6, Chapter 3, of your by-laws, I herewith submit my report as treasurer for the year 1911, or rather for that portion of it after August 26, 1911, the date of my election to this office.

Received from J. W. Hunter, Treasurer, by authority of the Board of Directors in full settlement of all amounts due from him to this Association.			$331.43
Receipts from current sources, August 26, 1911, to December 31, 1911.			2,789.50
Payment of Audited Vouchers for current Business, August 26, 1911, to December 31, 1911.		$1,785.81	
Balance on hand December 31, 1911:			
In Corn Exchange Bank, New York, N. Y.	$342.80		
In Essex National Bank, Montclair, N. J.	871.82		
In hands of Treasurer	120.50	1,335.12	
		$3,120.93	$3,120.93

Respectfully submitted,

(Signed) W. W. CROSBY,
Treasurer.

Baltimore, January 2, 1912.

Annual Report of the Executive Committee of the American Road Builders' Association

To the Board of Directors:—

In compliance with the constitution and by-laws of the American Road Builders' Association, the Executive Commitee presents its report for the year ending February 2, 1912.

Five thousand copies of a booklet containing a prospectus outlining the plan and purpose of the association, and including the constitution and by-laws, were printed in September, 1911. The larger portion of these has been distributed to members and prospective members.

Since its creation the Executive Committee has held eight formal meetings in New York, Boston, and Providence, for the purpose of making plans and carrying on the work of the association.

At a special meeting of the Board of Directors held at the Hotel Astor, New York, September 2, 1911, it was decided to hold the annual convention and congress at Rochester, New York, November 14, 15, 16, and 17. Your committee was charged with the responsibility of arranging the details of the meeting, and this work we endeavored to do in the best possible manner.

The congress brought together fourteen hundred delegates from the various parts of the United States and Canada, and it was felt by those who attended that the meeting was the most successful ever held in the United States, both from point of attendance and the interest shown.

In connection with the convention an exhibition of machinery and materials was given, which was participated in by fifty-five exhibitors. The representatives of the exhibitors present furnished the Executive Committee with signed statements to the effect that the facilities afforded by the association were adequate and that they favored such exhibitions under the auspices of the association.

In order to carry on the work of the association with greater facility and dispatch, the Executive Committee authorized the employment of a stenographer for the secretary's office and the purchase of a typewriting machine and desk. This equipment has, therefore, been added.

The attention of the members is called to the secretary's statement of receipts and expenditures and the balance

sheet showing the association's financial condition at the close of the fiscal year.

The reports of the secretary and treasurer are attached hereto.

EXECUTIVE COMMITTEE,
(Signed)
HAROLD PARKER,
ARTHUR H. BLANCHARD,
E. L. POWERS.

New York, N. Y., February 2, 1912.

PROCEEDINGS

OF

THE NINTH ANNUAL CONVENTION

OF THE

American Road Builders' Association

Held at Cincinnati, Ohio
December 3, 4, 5, and 6, 1912
together with
Reports of the Executive Committee, Secretary and Treasurer
Presented at the Annual Meeting
February 7, 1913

Price, Two Dollars

Published by the Association
150 Nassau Street
New York

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Chief Engineer, Board of Estimate and Apportionment of New York City

First Vice President
HAROLD PARKER, M. Am. Soc. C. E.
Ex-Chairman, Massachusetts Highway Commission

Second Vice President
J. D. MERIWETHER,
Road Engineer, New Mexico Good Roads Commission

Third Vice President
W. A. McLEAN
Provincial Engineer of Highways of Ontario, Canada

Secretary
E. L. POWERS
Editor, "Good Roads"

Treasurer
W. W. CROSBY, M. Am. Soc. C. E.
Chief Engineer, Maryland State Roads Commission

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TERM EXPIRES 1915

A. W. DEAN, M. Am. Soc. C. E.
Chief Engineer, Massachusetts Highway Commission

S. D. FOSTER, Assoc. M. Am. Soc. C. E.
Chief Engineer, State Highway Department of Pennysivania

P. L. HARDISON
State Highway Commissioner of Maine

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Ex-Deputy Commissioner of Highways of New York

W. J. ROBERTS, M. Am. Soc. C. E.
State Highway Commissioner of Washington

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Consulting Engineer

TERM EXPIRES 1914

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Manager, American Tar Co.

ARTHUR H. BLANCHARD, M. Am. Soc. C. E.
Professor of Highway Engineering, Columbia University

TERM EXPIRES 1913

LOGAN WALLER PAGE, M. Am. Soc. C. E.
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A. N. JOHNSON, M. Am. Soc. C. E.
State Highway Engineer of Illinois

WM. H. CONNELL, Assoc. M. Am. Soc. C. E.
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C. E. WOODBRIDGE
Sales Manager, The Texas Co.

F. E. ELLIS
Road Contractor

Executive Committee

NELSON P. LEWIS

E. L. POWERS

F. E. ELLIS

The Third American Good Roads Congress and Ninth Annual Convention of the American Road Builders' Association, including the Fourth Annual Exhibition of Road Making Machinery, Materials and Appliances, were held at Cincinnati, Ohio, on December 3, 4, 5 and 6, 1912.

During the four days of the convention there was a total registration of 1,303, which included representatives of a large majority of the states of the Union, the District of Columbia and Canada. Besides those who registered, there were others who attended one or more of the sessions of the convention or visited the exhibition. Although the registration included people interested in the subject of roads in a variety of ways, an unusually large proportion consisted of men actually engaged in some branch of road work, principally as public officials, engineers or contractors. Of the states in which there are established highway departments, 15 were represented by one or more department officials of the highest rank, many of them sending large delegations of officials and engineers. Contractors also, were present in especially large numbers, as were road engineers in private practice, and probably the most noteworthy feature of the attendance was the great number of engineers connected with city street departments, either as city engineers, superintendents of public works or in similar capacities.

The proceedings of the convention were divided into seven sessions, of which six were devoted to the consideration of road and street matters through the presentation of papers and the holding of informal discussions. In addition, one evening meeting was held, at which illustrated talks were given by representatives of material manufacturers, and a business meeting of the American Road Builders' Association was held at the close of the Thursday afternoon session. All of the sessions of the convention were held in Music Hall.

The exhibition of road building machinery, materials and appliances, comprising displays by 66 exhibitors, was held in the large exhibition hall on the main floor of the same building. In addition to these, 19 other exhibits, including that by the United States Office of Public Roads and those of states, cities and educational institutions, were shown on the floor above, making in all 85 separate exhibits.

Proceedings
of the
Ninth Annual Convention

FIRST SESSION

Tuesday Forenoon, December 3

The opening session of the Convention was called to order at 11 o'clock by President Nelson P. Lewis, Chief Engineer of the Board of Estimate and Apportionment of New York City, who introduced Mayor Henry T. Hunt of Cincinnati at the first speaker.

Mayor Hunt extended the welcome of the city of Cincinnati to the delegates, and spoke briefly on the importance of good roads. In the course of his address he said: "A few centuries ago the mind of man was devoted largely to the consideration of Heaven. Today, we are trying to make the earth more heavenly, and your splendid good roads movement is one of the best exemplifications of this modern training."

Congressman-Elect Stanley E. Bowdle followed Mayor Hunt, and, as the representative of Governor Harmon, extended the welcome of the state of Ohio. He also touched upon the advantages of an improved road system and referred to the situation in Ohio. It was his belief that, although the $50,000,000 bond issue had been defeated, the next Legislature would enact a law providing sufficient funds for road improvement without issuing bonds.

Thomas L. Pogue, Prosecutor of Hamilton County, Ohio, spoke next, extending the welcome of the county and speaking briefly of what had been accomplished there in the work of road improvement. He said that during the past five years Hamilton County had rebuilt 350 of its 800 miles of road and that the work would be continued until every mile had been improved.

Walter A. Draper, President of the Cincinnati Chamber of Commerce, followed Mr. Pogue, and welcomed the congress on behalf of the Chamber of Commerce. During his address, Mr. Draper referred to the activities of his organization and to the importance of securing the cooperation of the business man and taxpayer in road improvement and other public work.

President Lewis on behalf of the American Road Builders' Association made the first response to the addresses of welcome. In it he expressed the association's appreciation of the welcome that had been extended to it by the city, the county, the state and the Chamber of Commerce, and also expressed the pleasure of the delegates in coming to Ohio for the meeting. Referring to road work in that state, he called attention to the manner in which its road builders had utilized local materials, especially the excellent paving brick made in the state, and also commended the decision of the citizens to pay cash for their roads. After outlining briefly some of the interesting features of the city of Cincinnati and referring to the opportunity afforded to delegates to observe the administrative organization in Hamilton County, President Lewis introduced Frank F. Rogers, Deputy State Highway Commissioner of Michigan.

Mr. Rogers, speaking on behalf of the state highway officials who had come from other states, expressed their appreciation of the welcome extended and touched briefly upon the advantages to be gained by the study of methods employed in other localities. "If we expect," he said, "to make any progress in methods of road building—as well as anything else—it is necessary for us, as road builders, to first know what has been done by other road builders in other ages and in recent times in other states." Continuing, he pointed out that while materials and methods found suitable in one locality would not necessarily be suited to another region, yet a road builder could profit by acquainting himself with the practice in other parts of the country and by studying the results obtained, taking due account of the varying local conditions. In closing, he said that the delegates were present to learn, and he hoped that everyone would speak plainly of their failures as well as their successes, so that the delegates could go away feeling that they had spent a few days profitably.

At the close of Mr. Rogers' address, President Lewis introduced Hon. Francis T. Reeves, Mayor of the city of Waterbury, Conn., to respond on behalf of visiting city officials. Mayor Reeves said at the beginning of his remarks that, although during his term as mayor he had visited many cities in the capacity of delegate, he had never before been enabled to voice his personal appreciation of be-

ing made welcome. The average city official, according to Mayor Reeves, is remarkably susceptible to the welcoming spirit, but the city official possessed of any considerable ginger and attempting to accomplish something for his community is more apt to be an expert dodger of rhetorical brickbats than he is to be a grateful recipient of verbal bouquets. In closing, Mayor Reeves said that he wanted to express to the mayor and members of the Cincinnati Chamber of Commerce the feeling of good fellowship which the people of the East had for them, because in the East they had begun to learn that they could acquire a great deal of information from their fellow officials in the South and in the West.

At the close of Mayor Reeves' address, President Lewis announced that he had hoped to be able to introduce to the convention M. Jean de Pulligny, Chief Engineer of Roads and Bridges of France and Director of the French Mission of Engineers to the United States, but that he had not arrived, though he would be there later, and an opportunity would be had of hearing him.

President Lewis then announced that the Chair would entertain a motion for appointing committees on credentials and on resolutions, and, on the adoption of a resolution offered by Deputy State Highway Commissioner Rogers of Michigan, President Lewis appointed the following committees:

Credentials: Robert A. Meeker, State Highway Engineer of New Jersey; Robert C. Terrell, Commissioner of Public Roads of Kentucky; Frank F. Rogers, Deputy State Highway Commissioner of Michigan; Samuel Hill, Honorary Life President of the Washington State Good Roads Association; Roy W. Schenck, Secretary of the Laramie County Good Roads Association, Wyoming, and E. L. Powers, Editor of "Good Roads," of New York.

Resolutions: Harold Parker, formerly Chairman of the Massachusetts State Highway Commission; Arthur N. Johnson, State Highway Engineer of Illinois, and Arthur H. Blanchard, Professor of Highway Engineering at Columbia University.

President Lewis then introduced Samuel Hill, who addressed the meeting briefly, expressing his pleasure at being present and referring to the activity of the people of the West in the movement for road improvement. There

was an election during the year in Washington, Mr. Hill said, and it was a good roads election—no man was elected in the state who was not on the good roads platform.

At the close of Mr. Hill's address, the convention adjourned until afternoon.

SECOND SESSION

Tuesday Afternoon, December 3

PRESIDENT LEWIS: There is nothing in the constitution that requires the president of the associaiton to make an address of any kind, but it has seemed to me not inappropriate that the president should briefly outline to you just what this association is, and what it stands for; and that is the only reason for this address.

PRESIDENTIAL ADDRESS

By NELSON P. LEWIS

Chief Engineer of the Board of Estimate and Apportionment of New York City

Before proceeding to the papers and discussions which are included in our program, it may not be out of place for the President of the American Road Builders' Association to present a brief statement as to what the organization is and what is the excuse for its existence.

First: What is it? It is simply what its name indicates; an association of road builders; that is, of men who are engaged in the planning of highways and systems of highways, both rural and urban, and in their construction and maintenance, whether the work be that of administration, design, supervision, construction or the supply of the materials and plant employed in construction and repairs. Believing that administrative officers may have been too much disposed to consider their own problems as the most important, that engineers may have been inclined to underestimate the importance of the parts played by the administrators and the contractors, and that the contractors have, in turn, felt that both of the others are their natural enemies, and that the normal relation between them is to "do" or "be done," this association has endeavored to bring together in relations of friendly equality all who are en-

gaged in the improvement and care of public roads. If you will look over the program for this convention, you will see that problems in all of these branches of road work are to be presented and discussed by men whose opinions are entitled to consideration and respect.

That the association has in its membership those who are qualified to address you upon these subjects, is indicated by a circumstance to which your attention may with propriety be called. The Third International Road Congress is to be held in London in June of next year. Upon each one of the questions to be submitted to the Congress, papers may be presented by one person from each country. On some of the subjects two and even three writers are to collaborate, there having been twenty-five separate authors of papers designated for this country. Of these twenty-five authors no less than eighteen are members of the American Road Builders' Association, while the names of eleven are found in the list of its officers and directors. That members of the association may be presumed to possess the technical knowledge to enable them to speak with authority upon the technique of road building is further indicated by the fact that of its twenty-four officers and directors, fifteen are members or associate members of the American Society of Civil Engineers. These facts will justify the statement already made as to the qualifications of members of the association to present and discuss the questions which we are here to consider.

This is not a propaganda organization. Believing that all intelligent citizens appreciate the great economic value of good highways, we do not feel that it is necessary for us to devote our energies to stimulating good roads enthusiasm. We believe, however, that a sharp distinction should be drawn between a mere increase in the mileage of smooth road surface and the creation of a carefully thought-out system of highways, skillfully located, well constructed, intelligently maintained and honestly financed. While the interest of the abutting owner in the character of the street or road in front of his property is very keen, the interest of the city or town in its highway system is still greater. More important still is the influence of a convenient and well maintained system of roads upon a metropolitan district, a county or a group of contiguous counties; while exceeding all in importance is the coordination of the high-

ways of cities, towns, counties and even adjoining states, so that every community and every interest shall feel the quickening influence of a great improvement, well planned and thoroughly executed—an influence which will extend to and powerfully affect the national life and spirit.

A convenient and orderly street system for a city cannot be developed if the whim or selfish interest of each of the abutting owners is to control the position of the street or the character of the pavement. A rational and economical system of state roads cannot be created if political or geographical considerations are to control the location of the roads and the order of their improvement. Intelligent and patient preliminary study is required in both cases if the best results are to be realized by the city or the state. Such scientific treatment of the problem of the planning of a highway system is one of the things for which this association stands.

A general plan for a highway system having been formulated, the next step is the determination of the character of the improvement to be adopted for each street or road. The character of the soil, the gradients, the amount and kind of traffic to be provided for, the suitability of local material and the amount of money which is available for the improvement, should all receive careful consideration. Where traffic conditions will be severe and there are sufficient funds, the most thorough construction and the most durable surface should be provided, even though the material must be brought from distant sources of supply. If there is no first-class stone available for road metal, gravel or a less durable stone can be used to build a greater mileage than would be possible if expensive imported material were used. A bituminous binder may be necessary in many cases to prevent excessive dust and rapid deterioration under certain kinds of traffic, but it does not follow that the day of water bound macadam is passed. In a state or district abounding in excellent clay products, why not use them, as is being so successfully done in the state in which it is our good fortune to hold this convention? In some of the prairie states, which are favored with exceptionally fertile soil, there is a great scarcity of stone suitable even for foundations, while their clay products are of very inferior quality. In such a case it may be possible to make, even from poor clay, a clinker which with river sand will

make a fairly good mineral aggregate for a moderate foundation to support a road surface made from imported material.

However well the details of construction may be worked out, however skillfully the materials may be selected, the road, when built, cannot be left to take care of itself. Plans for its maintenance should be thought out as carefully as those for its construction. Such a careful study of conditions and adaptation of resources to the desired results, both for construction and maintenance, are what this association stands for.

Not only should every detail of the work be intelligently planned, but it should be skillfully and honestly carried out. The city or the state should get value for all money expended. It should not get *more* than it pays for. The contractor is entitled to and should receive as much consideration as the engineer or the superintendent. If the work be well or ill done, all must share the credit or the blame, as the case may be. In the preparation of plans and specifications, and in the determination of the materials to be used, the experienced road contractor is often able to give valuable advice. He will usually do so without the expectation of special advantage to himself as a bidder, and the engineer should be big enough and broad enough to avail himself of such advice. Let us reason together a little more, and all of us, including the state or the city, will gain something by our so doing. It is this better understanding between all road builders and this spirit of co-operation that the association stands for, and with this end in view it has endeavered to place everyone on an equal footing in these conventions.

Another feature of our highways which has received scant attention up to the present time is their interest and attractiveness. It may seem to many of you that this is a matter of very little importance in comparison with the utility and the economic value of good roads. The primary function of the highway, it is true, is to enable those using it to reach their objective points as quickly and as easily as possible; but there is an increasingly large proportion of those using our roads who are interested in something besides "getting there"; who are using them chiefly for health and recreation. A long stretch of straight road may enable one to reach the other end quickly and easily, but

it adds little interest to the journey, while it tempts to excessive speed, involving danger to the traveler and damage to the road surface. A slight detour might have given a broad outlook or a picturesque vista, adding greatly to the enjoyment of the pleasure rider and even arousing the interest of the more stolid driver of a heavy load.

The road once built, a little care bestowed upon the roadside, in the cutting of weeds, the planting of trees, the screening of bare earth slopes or rough bowlders by native bushes and trailing vines, which need practically no care, will make our highways a delight as well as a convenience to those using them. This is a detail which is well worthy the attention of this association and those responsible for the planning, building and care of our public roads.

While this association and those who are actually engaged in building and caring for our roads do not greatly concern themselves with campaigns to arouse interest in improved highways and legislation designed to secure them, we must have a keen interest in the manner in which they are to be paid for. We are convinced that good roads are worth almost any price, provided they are intelligently planned, conscientiously built and honestly financed. We cannot, however, regard with indifference the adoption of a financial policy in connection with road improvement, which, when its folly is realized, will give the cause a serious setback. The sums required to create and maintain a good highway system are so great that the first cost must be distributed over a number of years. In the case of any improvement which may be expected to last for several generations, it is but fair that those who are to enjoy the benefit should share the burden. If the improvement will not last for more than a decade, it is obviously unfair for us to buy it and enjoy it during its brief life and incur a debt which the next generation must pay. It is a practice all too common for our cities and states to pay for their pavements and roads from the proceeds of long term bonds covering a period several times as long as the probable or possible life of the street or road surface. The recklessness with which such obligations are incurred is alarming, and unless checked will surely lead to disaster. Where roads are newly constructed or where old roads are to be widened, grades improved and culverts built, this part of the work will be permanent,

and it is entirely proper that its cost should be distributed over a long term of years, but the road surface is temporary and may last five, ten, fifteen, and, in the case of well laid city pavements, twenty years or even more. It is not uncommon for states to issue 50-year bonds to pay for road improvement, and to expend from $12,000 to $20,000 a mile on country roads, the greater part of it on surface construction. If these bonds pay 4 per cent. interest, there will have been expended for interest and amortization by the time the roads are fully paid for, two and a half times the cost of their construction. A simple computation will show that this is equivalent to about $47 an acre on all of the land extending back half a mile on each side of the highway in the case of a road costing $12,000 a mile, and about $80 an acre in the case of a road costing $20,000 a mile. How much of the farm land in the average state has a greater value than this? But what about the road surface when it is finally paid for? It will have disappeared years before, or it will have been replaced three, four or five times, possibly each time with money borrowed for a long period, to say nothing of the amount expended in ordinary repairs. Or else—and this is an alternative which it is most unpleasant to consider—the next generations, indignant at the burden which we have placed upon them, will conclude that "the game is not worth the candle," will allow their roads to wear out without replacing them, and will relapse into the condition from which we are just emerging.

Do not misunderstand me. I would not question the wisdom or even the necessity of highway improvement on the most extensive scale. There may be those who think that they cannot afford good roads if they have to pay cash for them, that is, if their cost must be entirely met within the time measured by the life of the road. They *can* afford them. There is nothing for which the public is called upon to pay in taxes which will give them a better return for their money, provided always that the roads are intelligently located, and that the type of construction is adapted to the topography, to climatic conditions and to the character of the traffic. To spend $20,000 a mile where $5,000 will answer the purpose, is folly; to select for improvement roads which will be of special advantage to a few prominent political leaders but of little general

b nefit, is a breach of trust; to pay for them with money borrowed for a term of years far greater than the life of the roads, may appear easy, but it will prove to be very costly in the end. I believe I may speak for this association in saying that it is emphatically opposed to such policies, and that it questions the good judgment and business sense of those who favor them.

In conclusion, we do not advocate the improvement of our highways simply because we believe such a policy to be popular, but because we are convinced that there is no one thing which will more effectually promote the comfort, happiness and prosperity of the American people, provided the work is intelligently planned, well done and honestly financed. Realizing that the expenditures for this purpose will necessarily be enormous, our aim is to do what we can to improve the character of the work to be done and to encourage a wise use of the funds provided for the purpose.

PRESIDENT LEWIS: We are to consider this afternoon what is naturally the first great problem in highway administration and improvement: "The Organization of a Highway Department." It has been divided into three sub-topics: The organization for the state, for the large city, and for the county and town. The organization for the state will be presented to you by Maj. W. W. Crosby, Consulting Engineer to the Maryland State Roads Commission. Although you all know Maj. Crosby, I will go through the formality of introducing him.

ORGANIZATION OF A STATE HIGHWAY DEPARTMENT

BY MAJ. W. W: CROSBY

Chief Engineer, Maryland Geological Survey

In listening to the President's address, I was struck with a reference to what nowadays is considered as one of the most important features of engineering, and that is the question of efficiency. The attention of the tax paying public has been directed to the importance of that side of the question, and they in turn are beginning to demand more and more as time goes by that the moneys which they contribute for public improvement shall be made to go further and further. They have that right, and their demands should be gratified just as far as is possible for officials to

do so. Now, in the interest of efficiency it seems to me that we must first start right. We can't have an efficient machine—we can't obtain results efficiently—unless we have a machine in which there is as little lost motion as possible, a machine in which there are no superfluous parts, and for which too much care and too much lubrication are not required. In this matter of state highway work, especially, the question of the organization of the state highway department is one of the greatest importance, and it necessarily comes at the very beginning.

The essentials for a successful state highway department may be said to be:

1. An established demand for it.
2. A proper organization of it.
3. Sufficient funds for its work.
4. A well defined policy.
5. An honest, tactful, capable head.
6. Suitable locations for its headquarters and branches, proper equipment, and loyal and skilled employees.
7. Perfection in designs for its work and efficient execution of such designs.
8. A comprehensive system of accounting from which intelligible public reports are regularly made.

The title of this paper, and, as I understand, its purpose, confine the speaker to the second essential except as reference may seem necessary to one or more of the others, and such will be his effort.

From the speaker's experience, he believes that the subject of the organization of a state highway department should be viewed from two points. First, from the point of establishing such a department as will most likely succeed in acquiring for itself and for the movement for better roads sufficient stability to endure, and, second, from the point of view, after such a stage has been reached and public support both moral and financial assured, of then increasing its efficiency.

Now for the stable upbuilding of a state highway department, the speaker believes a state commission of three is best. Five are ordinarily unnecessary and less likely to form a facile and mobile unit. They are likely to separate into five units and not to amalgamate into one uniform and homogeneous body, and this lack of unity will surely produce rivalries and schisms.

One commissioner, on the other hand, is ordinarily weak in a number of points. The selection of one man with the necessary tact, honesty, and executive ability, and, at the same time, possessed of either the proper engineering skill or the recognition of his lack of it and with the breadth to acknowledge such lack by the employment of a skilled engineer assistant, is a most difficult task to set any appointing power. Further, with "but one neck to be lopped," a single-headed commission is far more susceptible to the temptations of politics and to the attacks of enemies. The demands of questions of policy, of law, of administration, of execution, and of engineering are too great and diverse to be satisfactorily and permanently met by more than one man in a thousand and the chances for the appointment of that man in any case are probably not one in one hundred when the various influences concerning such appointments, the salary likely to be offered, and all the other factors are considered. With a commission of three, properly selecting and protecting its engineer, the latter can do the public, his board, his subordinates and himself, much more nearly actual justice than if he is obliged to act as both commissioner and engineer.

Under any commission there should be employed a trained and competent chief engineer. Probably the commission will also need to employ a secretary and certain bookkeepers, clerks and stenographers reporting to and under the authority of the secretary. Legal counsel may be generally advisable and should report directly to the board or its chairman. A right of way agent may be necessary and he may report to the counsel or to the secretary, as deemed advisable. The chief engineer should be the chief executive officer of the board, and he should be given all the authority necessary to make this fact fully and finally realized. As such, his responsibility to the board would be definite and the board should do nothing to muddy the waters of this situation.

The speaker wishes to say here that it seems to him that more inefficiency, with its waste of money and unsatisfactory results, has come from division or lack of clearness in responsibility than from incompetence.

In such a position as above described, a chief engineer can not only afford to be perfectly open and frank in expressing his opinions to his board, but he is encouraged to

do so to the extremes of his ability. The board may then act more intelligently. In cases, where in its opinion the other considerations outweigh the engineering ones and the decision seems to be against the recommendations of the chief engineer, the latter feels his relief from the responsibility, and his efforts to properly carry out the decision of the board should, and probably will, be more earnest and effective.

Under the chief engineer should be two assistant engineers selected by him—as, it might be said here once and for all, should all the employees of the engineering department. One should be in charge of the construction, the other of the surveying and planning. But the plans should always go up to the chief engineer through the assistant in charge of construction. The benefit of criticisms from the workers in the field will then be had before it is too late to make changes without complications or serious expense and many of the routine difficulties of execution will thus be avoided.

As soon as the completed construction has reached an aggregate to justify it, the establishment of a maintenance division and the selection of an assistant engineer for its head should be had. Preferably this important step should be taken before it is clearly justified, rather than after.

The vast importance of proper maintenance of roads is beginning at last to be recognized by the states. One, at least, of the reasons for the better maintenance of European roads is unquestionably the absence, to a great extent, from the minds of those in authority over the roads there, of construction problems and consequently the concentration there possible on the minute, tedious, and recurrent details of maintenance. The proper solution of construction problems is not only of interest to almost all, but is also generally accompanied by early and shining rewards. That of the maintenance problem seldom, if ever, is quick or spectacular. Naturally construction problems attract, while those of maintenance seem drudgery. Long, persistent effort in little ordinary matters is demanded of the maintenance division. No greater mistake can, in the speaker's opinion, be made than to expect the maintenance to be satisfactory where the engineer in charge of construction is required to look after it also. This holds good

surely above the point when the maintenance expenditures are up to 10 per cent. of its construction expenditures annually.

Under the assistant engineers (and perhaps more especially under those in charge of construction and of maintenance), division engineers, resident engineers and inspectors will be arranged and needed according to the territory to be covered and the amount of work going on. Probably also, facilities for testing materials will have to be provided and the man in charge of such should report to the head of the construction or maintenance division according to the amount of work being done for each by him; or, he may report to both under some circumstances.

Under the assistant in charge of the surveying and planning will be needed one or more survey parties, draftsmen calculators, etc., the number of each depending on circumstances, as may readily be seen.

If the amount of work to be done annually is large, scattered and complex, the chief engineer will also need clerical assistance in the shape of a chief clerk or secretary, possibly a purchasing agent for materials for force account work, clerks and stenographers. The purchasing agent may report to the assistant in charge of construction or to the chief engineer directly, as deemed best. The chief clerk should report to the chief engineer directly and the clerks and stenographers to the chief clerk.

The responsibility for the entire engineering department resting clearly on the chief engineer, should be delegated by him only as may be warranted by the exigencies of the situation, and when so delegated, it should be done so clearly and definitely that there can be no doubt nor failure in the mind of anyone having business with the organization in understanding just what authority the subordinates have, at least so far as it concerns their business. There should be left no opportunity for a contractor to say that certain work or materials should be paid for in full "because the inspector or resident engineer saw it go in," nor should a contractor be able to say he was referred from one party to another for a decision on a point and, unable to get anything definite, he "had to do the best he could."

The delegation of authority, especially in a newly organized state highway department, must be made conservatively. The commission and its chief engineer may be

new to the work or to the situation, even if the engineer has been trained in similar work elsewhere. Naturally the public will look to them personally for decisions and for locating responsibility, and at first surely demand their personal, physical presence in many cases. The customary requirement for the employment as far as possible of local, men for the subordinate positions, at least, will render it advisable for the chief engineer to take on many bright and otherwise admirable young men except that they may be deficient in experience with modern highway work.

The rapid progress in the underlying science and the art of such work, makes it difficult for many beside the chief engineer to keep up-to-date in it, and, therefore, necessary for him to retain, until his subordinates become fully trained as regards the fundamentals of their work at least, sufficient authority, in perhaps a slight excess, for the best results. Further, the speaker has found that far less difficulties with contractors over points arising in connection with their work under the specifications become serious when considered and decided by the chief engineer in person than in cases where such decisions are left to younger and more inexperienced men. In fact many of these points are never raised when contractors know that the chief engineer himself will decide them and can be counted on to abide fairly by the specifications. Of course, unless the commission leaves the decisions provided by the contracts to be made by the chief engineer in the hands of the latter, and supports him in such, those contractors or others anxious to have their claims arbitrated by inexperienced or prejudiced parties may create, by appealing to the commission for decisions, an even worse situation than that in which the authority of the chief engineer's subordinates is not clearly defined or too much delegation of authority has been made to them. But relief from such a situation is from outside the remedies of organization.

From the foregoing may be had an explanation of the speaker's inclination toward the employment in new organizations of inspectors rather than resident engineers on the jobs to be done under him as well as for the retention in his own hands, while chief engineer, of perhaps more of his authority, as such, than in the similar work of many other organizations.

After the final establishment of a definite policy towards

its roads on the part of a state; after the proper provision of funds for the carrying out of this policy for at least a reasonably appreciable time; after the public has become accustomed to and a decent majority has settled down to the support of such a policy, and after the employees in the organization, who are likely to perhaps need authority, have become properly grounded and trained to support satisfactorily certain responsibility, then a change or development of the organization above outlined may be, and generally, is desirable for the sake of greater efficiency in the results from expenditures.

We may, therefore, now look at the matter of the organization of a state highway department from the second point suggested at the outset.

Efficiency should, of course, be kept in mind as desirable in the earlier consideration, but there as may have been hinted at least, it was not the only object, and consequently in the earlier days of the work, the efficiency from a purely financial standpoint may have been obliged to retire at times in favor of what seemed to be for the ultimate public good.

Now considering efficiency alone, the speaker believes that:

The Commission of three may well give way to that of one, or even in the latter case that a competent individual may satisfactorily fill such a position as engineer-commissioner, and the position of chief engineer, as well as the board of commissioners, be avoided. That the position of assistant engineer in charge of surveying and planning may, perhaps, with the central department for his work, be abolished and the work better done under the division engineers assigned to sections of the state. This, however, depends entirely upon local conditions and no general rule can be here laid down concerning the point. That it is possible to say the same concerning the assistant engineers respectively in charge of construction and of maintenance, as said immediately above; but in such a case, the necessity for avoiding any serious distraction from maintenance problems by those of construction, should be clearly and constantly kept in mind. That the delegation of more and more of the authority of the chief engineer may be advisable as the training of the subordinates proceeds and the reliance on them is warranted.

With these steps taken at the proper time, the expense for overhead charges should be reduced without depreciation in the value of the physical results and thus the efficiency of the organization increased. Inappropriately taken, they will quickly produce the opposite results on a large scale. The difference between a proper organization and an improper one may be only five per cent. of the total expenditures in the work and this difference can be readily offset many times by the difference in the quality of the physical results, the expenditures for which will probably amount to nearly 90 per cent. of the total expenditures.

The necessity for the proper organization of a state highway department should be recognized by all, but unfortunately the instances of such recognition, or at least the evidence by results of it, seem to be in the minority.

The speaker hopes that the discussion here of the matter, which discussion he has attempted to stimulate by a brief outline of some of his views, may be fruitful in good results.

PRESIDENT LEWIS: The next topic under this general subject is: "The Organization of a Highway Department for a Large City." This paper is to be presented by Mr. William H. Connell, Chief of the Bureau of Highways and Street Cleaning of the City of Philadelphia. I take great pleasure in introducing Mr. Connell.

THE ORGANIZATION OF A HIGHWAY DEPARTMENT FOR A LARGE CITY

BY WM. H. CONNELL

Chief, Bureau of Highways and Street Cleaning, Philadelphia, Pa.

The most important and most neglected branch of the municipal governments today, is the division of highways. This is probably due to the fact that only within the past few years has the public taken an active interest in the condition of the streets. Wide avenues, good pavements and clean streets are not only appreciated but demanded by the public today, which accounts for the significant fact that every live municipality is struggling to develop a highway organization that will enable it to meet the demands of the public.

The time has arrived when municipalities must develop highway organizations commensurate with the present day requirements of this all-important branch of municipal government. It is needless to say that the development of up-to-date municipal highway organizations, like the good roads movement, is in its infancy, but the two go hand in hand and have come to stay, and if any governing body wishes to be popular with the public, it will be well for it to look to its highways. The highways represent the most conspicuous show case of the municipal government—thus the importance of paying particular attention to the goods placed there. It pays and pays well for business establishments to design attractive show cases, place their best goods in the window, and maintain a clean and attractive display; and so it would pay municipalities well to design attractive highways, lay good pavements, and maintain clean and attractive streets. It must be remembered, however, that this cannot be done by wishing. But unfortunately a half-hearted policy has been the one most in evidence in many municipalities to satisfy the popular demand for attractive highways and good pavements. The solution of the problem is an up-to-date municipal highway organization, made up of the right kind of personnel working as a unit.

No matter how large or how small the municipality may be, the underlying principles constituting the foundation of the highway organization are the same. If a lawyer or business man were going to build a house, he would employ an architect, tell him how much money he had to spend, give him an idea of the size of the house wanted, and leave the rest to him. He would also select an architect with experience in the design of the type of structure he wanted. The same procedure should be followed in organizing a municipal highway division, and it is a very simple one to follow. Select an engineer whose experience has been gained in highway organization work; tell him about how much money he will have to spend; give him an idea of the mileage and area of streets and the scope of the work coming under his jurisdiction; and he will build up a successful organization—provided he follows the same principles the architect must to design a substantial house, namely, select the materials best suited to suppor

the structure. The highway organization, like the house to be substantial must be composed of men capable of upholding and controlling the respective divisions of the organization coming under their control. If this procedure is followed, the organization will be permanent and will stand, unless seriously interfered with, even in the absence of the engineer who built up the organization, member by member. When an organization is perfected, it is in the same category with the completed house, simply requiring maintenance to hold its own. But if it is to be kept up-to-date, it will require changes and improvements commensurate with the demands of the time, and increased population—the house as well as the highway organization.

The outline of the underlying principles governing the procedure to be followed in forming a municipal highway organization makes it very evident that at most it is not a difficult task to start right, but right here municipalities only too often have failed. The lawyers and business men placed at the head of the public works departments have not followed the procedure they would in building a house or doing something else that would require a like amount of intelligence in the selection of the tools to work with. They have either attempted to build up the organization themselves, or have selected engineers whose principal qualifications have been that they were specialists in reinforced concrete, waterworks, sewer works, etc., or in short anything but highways. And what has been the consequence? These men spend three or four years or more groping in the dark, studying the rudiments of the requirements of a highway organization, and by the time they are just beginning to find themselves, and appreciate that highway engineering is a special branch of the engineering profession, the public has become impatient, and justly so.

This we all know has occurred only too often with well-intentioned administrations. Such control of the highway situation retards the advance of modern highway organization and engineering just as much as the old-time political administration of the highway bureau, and the reason is that the public expects something from the well-intentioned administration and doesn't get it, while in the latter instance they did not expect much and usually were not disappointed.

A proper start usually results in a good finish, but not without a hard fight, and even though the right engineer be selected to head a highway organization, his path is not strewn with roses. There is so much that is wrong and so little that is right in many of our municipal highway organizations, that the opportunity for constructive work is almost unlimited, aside from the efforts required even to keep abreast of the times with the construction work, and above water with the maintenance.

Assuming that a highway organization has reached the stage of development where its personnel is qualified to handle the work, the next and most important step toward efficiency and economy is to centralize the control of streets.

It may appear rather odd to some, but nevertheless it is a fact, that very few, if any, highway organizations control the streets coming under their jurisdiction. The control is usually divided up between the street railways, telephone, telegraph, electric light, gas, and other corporations. If when these companies tear up the streets they are permitted to make their own repairs, there results a confusion which takes away from the highway bureaus the direct control of street repairs. Such arrangements as are necessary should be made to place all repair work directly under the highway bureau. If the repair work is done by contract, the contract should be with the city. The highway bureau should have sole authority to repair or order repairs, of whatever nature, that are to be made. This would give the bureau a direct control over the contractors, and place the responsibility on the bureau for the condition of the streets and do away with the excuses we so often hear from city officials, that "The railway or telephone company is responsible for such and such repairs, and we are doing our best to push along the work." With this divided responsibility for the condition of the streets we can never expect to reach the highest point of efficiency in our highway organization. The parkways and main park driveways should also be under the control of the highway bureau as there should be but one system of highway construction and maintenance in the municipality.

The principle of centralization of control is the governing factor in a municipal highway organization, as it is also in any other organization of whatever nature. No business enterprise can compete with other business enter-

prises and be successful, unless the control of the organization is centralized and all the branches and subdivisions are cooperating and working as a unit for the success of the enterprise. This can be accomplished in a highway organization only by first assuming such control of the streets that the responsibility for all conditions that may arise will be placed unqualifiedly with the highway bureau. Second, the subdivisions should be so organized that they will all be in close touch with the central office and working as a unit; there must be no overlapping of jurisdiction, and the policy emanating from the main office as to methods of carrying on the work, should permeate the whole organization. Each factor in the organization, from the common laborer up, should be schooled in a sense of his responsibility and know where it begins and ends. No man will do his best work unless he be instilled with a sense of his responsibility. The success of the organization at large depends upon cooperative efforts which can be brought about only through the centralization of control, and such control cannot exist unless each individual in the organization is charged with his responsibility. If more attention were paid to the old saying, "Men will be led, but not driven," there would be less disorganization in municipal highway and other organizations.

Another very important step toward the control of street repairs is the establishing of municipal repair forces. The city should not be forced to depend upon contracts for work of this character and indeed, the only way to control completely wear and tear repairs as well as cuts is through municipal forces. Such repair forces naturally fall into four divisions: Asphalt, stone block, wood block and brick, and macadam. In a few cities some success has been obtained with city gangs in repairing wood block and asphalt block streets but the big problem does not include either of these. Properly organized, a municipal asphalt plant is a step toward centralization of control over pavements, provided the area of asphalt pavements warrants a plant for repair work. No less important, however, are the repair gangs for the granite, brick and macadam pavements.

It is only within the last few years that the engineer has been finding out that city labor, properly handled, is far superior to that obtained through contracts. Ease in administration requires a municipal force for repair work

as mobility cannot be obtained through any other than city forces. In addition to this fact, it might be well to add that results obtained recently in various cities show a substantial saving by reason of the abandonment of contracts for repair work, and the substitution of city labor.

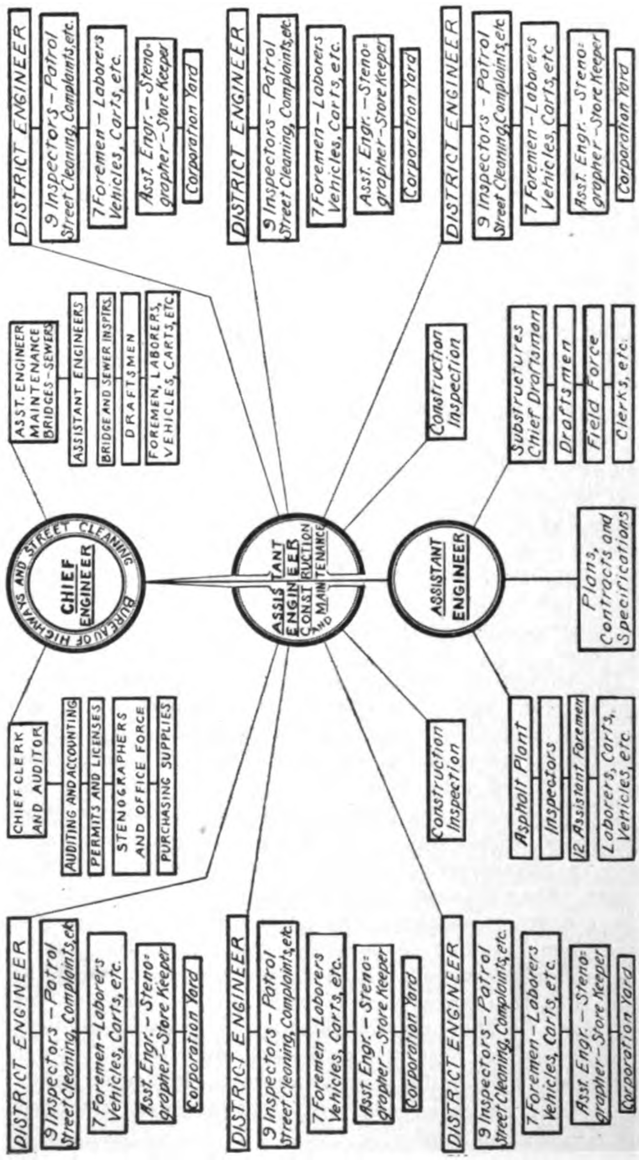
Too much emphasis cannot be placed upon the importance of centralizing the control over the pavements right in the highway bureau itself—and the larger the municipality, the more important it is that all street repairs be made by municipal forces. In any event, even though the organization is not equipped to handle the work, all contracts for repairs to cuts should be made directly with the city and not with the public service corporations. The most efficient and economic method of handling repairs, however, is by municipal forces.

After planning and working out a highway organization adequate for the requirements of the municipality, the first and most important step toward efficiency and economy in carrying out the work is the establishment of unit cost records, covering all classes of work carried on under the bureau. The basic principle of these records is simply to bring out by comparison the weak and strong points of the organization, which will act as a guide in planning and conducting the work in an efficient and economical manner. Comparisons of different subdivisions of one function of the organization may be made one with the other, or comparisons of like functions in different organizations, all of which tends to improve the methods of carrying on the work, impresses the men with their responsibility and at the same time arouses the sense of pride they should have in their work. Unit cost records are simply a modern system of records designed to raise the standard of efficiency and economy in conducting work. All maintenance work should be initiated through job orders issued from the main office, with the exception of emergency repairs, which work should be controlled through a job order issued by the superintendent or engineer in charge, a carbon copy of which should be transmitted to the main office. The foreman should be supplied with a force account and daily report sheets, through which labor hours, foreman's time, team time, and material used could be charged under their respective job order numbers and each day transmitted to the main office where the unit cost records would be compiled.

The accompanying chart illustrates a proposed organization of a bureau of highways which embraces construction and maintenance of highways, street cleaning, collection of garbage, maintenance of bridges and maintenance of sewers in a municipality, with a population of about 1,600,000, and 1,500 miles of streets and roads to care for, of which 1,000 miles are paved with first-class pavements, 300 miles with water bound and bituminous macadam and 200 miles of dirt roads. It is assumed, of course, that all street repair work and bridge and sewer maintenance, as far as is practicable, will be done by municipal labor, and all original construction and repaving by contract.

The organization, it will be observed, is divided into five main divisions, which in turn are subdivided in accordance with the requirements of the functions of the respective divisions. A chief clerk is in charge of the clerical force, which embraces auditing and accounting, permits and license division, stenographers and clerks purchasing supplies, etc. The maintenance of bridges and sewers is under the direction of an assistant engineer, and is subdivided into two divisions, maintenance of bridges and maintenance of sewers. All minor repairs to bridges and sewers are made by municipal labor, more extensive repairs by contract. Sewer cleaning, of course, is done by municipal labor.

The supervision of all regulating and grading of streets, construction and maintenance of pavements and street cleaning is divided into two main divisions, each under the direction of an assistant engineer. Both of these divisions are subdivided into three districts, each under the direction of a district engineer. Each district has nine patrol inspectors, whose duty it is to report and measure all defects in pavements, plumbers' cuts, corporation cuts, and report encumbrances, answer complaints, etc., and supervise the street cleaning and collection of garbage, which have been assumed to be under contract in the organization under discussion. It is strongly recommended, however, that this work be performed by the municipality itself, as it is the only logical way to properly control it. It will also be observed that each district engineer has under his jurisdiction seven foremen, laborers, vehicles, carts, etc., assistant engineer, stenographer, storekeeper and corporation yard.


CHIEF ENGINEER
BUREAU OF HIGHWAYS AND STREET CLEANING
CHIEF CLERK AND AUDITOR
AUDITING AND ACCOUNTING
PERMITS AND LICENSES
STENOGRAPHERS AND OFFICE FORCE
PURCHASING SUPPLIES
ASST. ENGINEER MAINTENANCE BRIDGES-SEWERS
ASSISTANT ENGINEERS
BRIDGE AND SEWER INSPTRS.
DRAFTSMEN
FOREMEN, LABORERS, VEHICLES, CARTS, ETC.
ASSISTANT ENGINEER CONSTRUCTION AND MAINTENANCE
ASSISTANT ENGINEER
DISTRICT ENGINEER
9 Inspectors - Patrol Street Cleaning, Complaints, etc.
7 Foremen - Laborers Vehicles, Carts, etc.
Asst. Engr. - Stenographer - Store Keeper
Corporation Yard
Construction Inspection
Substructures Chief Draftsman
Draftsmen
Field Force
Clerks, etc.
Plans, Contracts and Specifications
Asphalt Plant
Inspectors
12 Assistant Foremen
Laborers, Carts, Vehicles, etc.

The number of patrol inspectors, assistant engineers, foremen, laborers, etc., may vary somewhat, depending upon the requirements of the respective districts, but the total number is approximately correct for the municipality at large.

Construction inspectors are assigned to each district as occasion requires by the assistant engineers of construction and maintenance. The other main division comprises the office force in charge of plans, specifications and contracts, the asphalt plant, and the division of subsurface structures, and is under the direction of an assistant engineer. The division of subsurface structures is a most important division, and the rules and regulations governing the placing of subsurface structures in the street, after a pavement has been laid, cannot be too strict. This is one of the most serious problems confronting the municipal engineer, and indications point to its not being under proper control in any municipality in this country. The only real solution of the problem would seem to be underground pipe galleries. The evil, however, can be minimized by exercising a more thorough control over the corporations by insisting on a strict compliance with rules and regulations designed to permit of as little disturbance as possible to pavements after being laid.

A testing laboratory has not been mentioned, as it is assumed that the municipality would have a laboratory equipped to handle the work of all the city departments.

The primary considerations in making up the accompanying chart were to illustrate a practical scheme for carrying on the work of an organization, such as referred to in this paper, by subdividing the responsibility for the work in such a manner that the chief engineer will not be swamped with detail, but at the same time will be in such close touch with all the work under his jurisdiction that he can intelligently direct and thoroughly control the operations of the bureau.

The organization under discussion has been used as an illustration in this paper, as it is one with which the writer is familiar, but is not presented as an ideal municipal highway organization—the object simply being to illustrate the essential features that must necessarily be considered in order to successfully control a municipal highway organization. The fundamental principles under

discussion, however, would apply to any like organization; any deviations would simply be of minor detail.

PRESIDENT LEWIS: Those of us who live in large cities manage to get along somehow or other even with indifferent administration of our highway systems, but the majority of our people live in smaller places and are interested chiefly in the efficiency of the county and township units of administration, and this subject is to be presented to you by Mr. A. N. Johnson, State Highway Engineer of Illinois, whom I am glad to introduce to you.

COUNTY AND TOWNSHIP ORGANIZATION OF HIGHWAY WORK

BY A. N. JOHNSON

State Highway Engineer of Illinois

In many states the political unit that has charge of local road maintenance is the town. In outlining an organization for building and maintaining public highways in a town or a political unit of a similar size, certain definite assumptions must be made; and those enumerated below probably apply in a general way to such units throughout the United States.

The mileage of roads to be cared for is assumed to be from 75 to 100, of which approximately 75 per cent. are earth roads; the bridges and culverts are to be in the care of the same organization as the roads.

It is also assumed that the town officials do not have charge of the maintenance or construction of sections of heavily traveled through roads that may lie in the town, but that these main roads form a part of a state system under the maintenance of a state highway department.

A reasonable amount of money is to be available for the work to be done, and it is assumed that macadam or other hard roads are to be built by contract and that all bridges costing to exceed $400 to $500 are to be built by contract. For convenience in the discussion, the unit for which the organization is designed is designated throughout as the town.

The Town Road Commissioner.—The entire responsibility for the work in the town should be in the hands of one man designated as the town road commissioner. He

should be elected by the voters of the town for a term of three years on a non-partisan ticket under a system whereby the man having the highest number of votes is declared elected to the office. His pay should be a fixed percentage of the regular road and bridge levy of the town—about 10 per cent., but in no case less than $200 nor more than $500 per year.

It is expected his duties will be administrative only, and require but one or two days a month on an average. There should be one fixed day each month when he may be found at a designated office in the town, on which days contracts should be let and other business transacted. He should be the custodian of the town road funds, and in order to safeguard his expenditures he should be required to publish a list of disbursements each quarter. The town road commissioner should have full charge of all road work in the town, make all contracts for road work and for bridges for the township and should be obliged to hire a road superintendent. He should be subject to a properly safeguarded recall.

The actual work on the highways should be in charge of the road superintendent employed or appointed by the town road commissioner and responsible only to him. The road superintendent should be employed by the year, on a monthly wage basis, being required to give his entire time to road work. He should be custodian of the equipment owned by the town and be responsible for its care and upkeep. He should have authority to hire men and teams necessary for doing the road work in the town, subject to the approval of the town road commissioner only. The men and teams used on the road work should be, so far as possible, employed on a monthly wage basis and for the entire construction season, and should be under the authority of the superintendent, take orders from and report directly to him.

All taxes for road and bridge purposes in each town should be paid in cash, the maximum rate allowable to be fixed by statute. But within such limits, the rate should be fixed by the road commissioner, and should be entered by the proper county officers as a tax against all property in the town, including railroads and other corporations situated therein. The evils of the labor system are too well known to need detailed mention. There are few

communities where a valid excuse can be offered for any such inefficient and demoralizing method of doing public work.

Franchises for Rights of Way.—It is believed that no franchises for rights of way within the public highways should be at the disposal of as small a unit as the town, but could well be extended, under proper statutory limitations, by the county boards. Franchises for electric railroads within the limits of highways should be prohibited by law except within the limits of incorporated villages and cities. It is with such larger matters affecting the welfare of the town and its highways that the highway commissioner should deal and the office should be so constituted as to permit the best equipped men—the busy men, the men of affairs—to be able to and desirous of undertaking the work. The duties should not include a lot of small detail much better left to some skillful superintendent.

Equipment.—The following equipment can usually be economically used in an average town: A power grading outfit, i.e., some kind of power tractor and heavy grader; a small grader for team work; 10 to 15 road drags, and the usual equipment of small scrapers, shovels, plows, picks and similar tools. In exceptional cases the town may use economically, particularly if there is a considerable mileage of hard roads to be maintained, the following: One or two conveniently located gravel pits or stone quarries, and in the latter case a stone crushing plant with a capacity of 100 cu. yds. per day; a concrete mixer, and collapsible culvert forms.

Patrolling the Roads.—All of the roads in the town except possibly a few infrequently traveled by-roads, should be patrolled once a month by the road superintendent. Special inspection trips might be necessary in addition to the regular monthly patrolling, but these would involve only visits to certain sections of road which had been reported as being in improper condition. In addition to patrolling all the roads once a month, the road superintendent should patrol the main traveled roads in the town at least once a week.

Construction Work on Roads.—All construction work in the way of grading and shaping earth roads should be done early in the season, the work beginning as soon as the roads have settled sufficiently to permit the use of proper machinery. In this work, the road superintendent

should act as foreman, and be in immediate charge of the construction work and give his time continuously to it.

The work should be done by the most approved and efficient methods, using a grader drawn by some sort of a power tractor, and the work should be planned so as to inconvenience the public as little as possible consistent with doing economical work. If heavy grading, as cutting hills or raising roads by means of embankments, must be done, the work should be laid out and grades established by a competent engineer. The superintendent should then work to the grades so established, using teams and scrapers. Such work should be done as early in the season as practicable, so as to permit the newly made embankments to be compacted before the winter season comes on. All such work can conveniently be done by day labor with the regular force employed in road work.

Construction Work on Culverts.—After the necessary earth work on the roads has been completed, the force should take up the construction and repair of culverts. This work can be done conveniently in midsummer and early fall. At this time the streams are usually at low water and the work will be interrupted the least by rainy weather and high water in the streams. Plans should be made and materials purchased for all the work which it is intended to do in one season, and this work should all be done at one time, the township gang working continuously at the culvert work until it has been completed.

In many instances the town might well adopt a general type of culvert, and if once a satisfactory type were decided upon, it could be used throughout the town, thereby permitting the use of forms repeatedly and making it unnecessary for the town force to become familiar with more than one general type of construction. In this way, the greatest efficiency of the men could be secured at the least expenditure for superintendence.

Bridge Work.—The construction of all bridges or culverts having a span of 6 ft. or more should be in accordance with general specifications as established by the state highway department. The plans and specifications should be prepared during the winter and the contracts let in the early spring. The construction of the bridges should be carried out under the supervision of an inspector, and approved by the engineer. Bridge work is mentioned later.

Maintenance Work on Earth Roads.—After the earth road construction work had been completed in the early summer, a certain amount of grading work would be necessary in order to maintain the proper shape of the roads during settlement. Such work would usually be done by teams and a light grader, and arrangements should be made by the town superintendent to follow the construction work with a proper amount of grading so as to maintain the condition of the surface and the general shape of the roads until the roadways had become thoroughly compacted.

In addition to the maintenance work which could be done with a small grader, there would be a large amount of maintenance work to be done by means of the split log drag, or other similar form of drag. Inasmuch as the dragging would usually have to be done throughout the town within a period of a very few hours, if the work were to be done while the soil was in proper condition, it would be necessary for the road superintendent to have men who lived in various parts of the township employed for this purpose with the understanding that they would drag certain sections of road immediately upon receipt of notice from the superintendent. When the superintendent found conditions suitable for dragging, he would notify the various men throughout the town and the work could be done within a few hours.

In order to have efficient dragging work done this arrangement would be necessary, particularly in the early fall and winter, when it often freezes suddenly after a heavy rain making the roads very rough unless they have been dragged just before freezing.

It is very important to maintain a perfect system of drainage on all roads throughout the year, and it is particularly desirable to have the roads enter the winter-and-spring period without obstructions to drainage anywhere. Late in the fall the roads should all be gone over and all culverts cleaned out, weeds and grass removed from the ends and the ditches along the roads carefully cleaned and opened, so as to insure a free flow of water to the culverts and outlet ditches.

Maintenance of Hard Roads.—Maintenance work on hard roads should be carried out in midsummer except that emergency repairs should be made at any time when it seemed advisable. The general overhauling or surfacing of

any section of hard road can be most conveniently and economically done in midsummer or early fall, and under the operation of systematic maintenance most of the necessary work can be done by means of small tools, such as picks, shovels and tampers, without the use of the steam roller or other heavy appliances.

The construction of hard roads should be carried out by contract. Plans and specifications for the work should be prepared by a competent engineer and the construction carried out under suitable inspection by the engineer, or an inspector approved by him. The contracts should be let in the early spring, and if the roads are to be surfaced with a bituminous compound, provisions should be made for the completion of the work prior to October 1, or at least provisions should be made that no work should be done when the atmospheric temperature is less than 60° F.

Maintenance Work on Bridges.—It is expected that the organization will take care of the necessary maintenance of bridges, such as reflooring and repainting and provisions should be made for taking care of this work in the late summer.

Town Commissioner to Be Responsible.—In outlining a system for maintaining highways in a small political unit, it is believed to be desirable to concentrate the responsibility for the work in one person, and if this is done, then the one person who is responsible for the work must also be given full authority; therefore, the road commissioner should have full authority for carrying on the work in the town.

First-class work can be expected only when men are compensated for it. Therefore, the compensation for the men doing road work in the town should be ample for the class of work they were required to do, and particularly the superintendent should be well paid. The success of the operation of the entire system would depend upon the selection of a suitable town commissioner, and, in accordance with the ideals of a representaive government, it is believed that this officer should be elected by the people—with a full realization that in some cases incompetent men will be elected.

By making the office non-partisan, competent men would usually be secured for the position. Since the commissioner would be held responsible for all the work done in the township, he would have to have full authority in

securing his assistants, and all men doing road work and all inspectors working in the town should report to the town commissioner. Inasmuch as the office would entail the handling of considerable sums of money, the road commissioner should be placed under a suitable bond, and the disbursement of this fund should be placed under proper legal safeguards such as the one requiring vouchers covering all expenditures to be kept on file. He should be required to publish at least once a quarter a statement showing all the expenditures during the preceding quarter, including expenditures for supplies and expenditures for labor, salaries, etc. It is also believed that the office should be made subject to recall upon petition and vote of the people in the town.

Contracts Let at Public Letting.—The commissioner should be required by law to let all contracts for road and bridge work after public advertisements and at public lettings, and upon properly prepared plans and specifications. He should also be required to purchase all supplies amounting to more than a certain maximum in any month by advertisement and public letting of contract.

It is intended that the position be one of business management, and that it shall not necessarily be a technical position; therefore, provisions should also be made by law for the proper engineering supervision of any work done in the town which required technical skill not to be expected of the commissioner.

General Order of Work.—The various classes of work that ought to be done in a township can be so arranged that a regular force of employees can be kept busy throughout those months of the year when weather conditions permit construction work. This force may be large or small, depending upon the condition of the roads in the town and the amount of traffic, and consequently the amount of maintenance necessary. But whether it be large or small, it should be maintained as nearly as possible throughout the construction season so as to take full advantage of the expertness and experience which the men would obtain in doing the class of work required of them.

It is often found that contracts for construction work can be most advantageously let in the winter or early spring prior to the season in which the work is to be done. Contractors can usually make more satisfactory arrange-

ments for materials at that time than later on in the season and are sometimes willing to bid closely so as to insure themselves of a big volume of work for the season.

Several kinds of road work necessary in a town can be done about as well at one time of the year as another, while other kinds ought to be done at certain seasons in the year. Between these the town crew can be kept constantly working during the year. For example, earthwork, grading and shaping of roads should be done as early in the season as possible, and it might be convenient at the same time to finish any incomplete drainage work, such as the opening up of ditches or the laying of tiles. Or it might be found that the latter work could be more conveniently postponed until later in the season. Likewise in the repair of water bound macadam or gravel roads, there is no great difference between doing the work early in the spring or later in the fall, but in general, the work cannot be conveniently and economically done in midsummer, because the proper repairs of the road require that they shall be kept wet until traffic has thoroughly compacted the portion that has been repaired, and ordinarily this will entail some additional expense if the work is done in exceedingly hot, dry weather. If, however, the work is done in the early spring when there are frequent rains or late in the fall when there are rains and the weather is cool, it will be much easier to maintain the moist condition necessary to secure the cementing of the road material.

On the other hand, if there are bituminous surfaced roads to be repaired, the work can be more satisfactorily done in the hotter part of the season. In the same way, the repair of culverts can be taken care of at any time during the year, but during the midsummer and early fall the streams are more nearly dry and there will be the least delay on account of rain and high water in the streams.

Machinery.—Some kinds of machinery that can be economically used in a larger unit cannot be economically used in a town on account of the fact that the depreciation of these tools during the long part of the year they are not in use will more than make up for the saving effected by their use during a short part of the year. For example, if a township had a number of small concrete culverts to construct, it might be economical to purchase and use a small concrete mixer. A small mixer which will save nearly $1

per cu. yd. of concrete placed may be purchased for $300 or $400, so that if 300 or 400 cu. yds. are to be used in one or two seasons a small mixer will be found profitable, while a large mixer suitable for larger work would seldom be economical for a town to own. Likewise, if a town has a large mileage of macadam roads to be maintained, it might be worth while to have a power roller for use in maintaining the macadam roads. But, if on the other hand, a small mileage is to be taken care of, the work can be done with the ordinary small tools in a satisfactory manner, although not as cheaply as by use of the roller.

If the road materials are expensive when shipped into the township, it may be advisable to maintain a quarry and crushing plant, but if materials can be obtained on board cars in the town at a price of $1 or $1.25 per cu. yd., it will not ordinarily pay the township to maintain a crushing plant unless it is expected to use it continuously throughout the season. If a considerable amount of gravel or crushed stone roads are to be maintained, it would be advisable for the town to own and use special dumping wagons which could be drawn by the tractor and used for hauling material for these roads.

If the type of soil and general characteristics of the roads of the township are such as to permit the use of a power leveler which can take the place of the drag to a large extent, then this machine will be economical to use. If, on the other hand, the soil is of such a nature that it cannot be traveled by a tractor drawing a leveler at the time of the year when the leveler should be used, it will be necessary to resort to the use of the drag drawn by teams, and a power tractor and the leveler would not be an economical piece of machinery for the town to maintain. On light clay soils the leveler is not recommended but with heavy sticky clay and gumbo soils, a leveler can be used to good advantage.

Organization Must Be Simple.—In general, with the class of supervision it would be possible to obtain in any town, no very complicated system of construction or maintenance could be worked out successfully. A system of organization which would give high efficiency in a larger unit under more expert supervision might fail entirely in a small unit or at least become inefficient. It is believed that the most can be accomplished by concentrating responsibility

and authority in one man; when responsibility is fixed there is much gained in results. A town road commissioner selected by the people of the community would be easily accessible, and if his work were not satisfactory, it would be comparatively easy to reach him and secure relief from the disagreeable or undesirable features of his administration

County Cooperation.—In the foregoing discussion of the work to be done in a town comprising, as has been assumed, a comparatively small mileage of roads, it is seen that here is work that requires special engineering supervision and equipment that it is not practical for such a small unit as a town to provide.

To have available such engineering supervision and such equipment, a larger unit than the town seems necessary. Such a unit is furnished by the county and there should be a county highway engineer appointed by the county board to have general charge of all road and bridge work requiring engineering supervision. The county should own such equipment of more expensive machinery, such as rollers, bituminous spreading machines and concrete mixers, as might be efficiently employed on those roads requiring such apparatus; this equipment to be under the immediate supervision of the county engineer, and to be assigned by him to work in the different towns. A predetermined fixed per diem charge sufficient to operate and maintain this machinery should be ascertained by the county engineer, and such charge should be defrayed by the county and by the town actually using the equipment. The county engineer should draw and approve all plans for roads and bridges in the county exclusive of those upon the main system of roads, including from 15 to 20 per cent. of the road mileage which would be under direct control of a state department. The general specifications for all bridges should be furnished by the state department, those specifications to be used and followed by the county engineer in his design for individual bridges.

The smaller concrete bridges that require not to exceed 100 to 150 cu. yds. of concrete could well be constructed by day labor under the immediate direction of the county engineer, the county to furnish on such work, a concrete mixer, special collapsible forms, where such can be used, and an inspector to superintend the work, this portion of the construction to fall upon the county; the cost of all

labor and materials to be paid by the town. The initiative for such work should be taken by the town commissioners.

With a system of state roads under state maintenance to care for the roads that are the more heavily traveled and consequently the more expensive to maintain; with a county engineer at hand to direct the more important work on the secondary roads, and with the roads of lesser importance, which include the larger mileage left to be maintained as each community can best afford, a system of road maintenance and improvement is obtained that is well adapted to the needs of today with reasonable provision for the future.

PRESIDENT LEWIS: This general subject of organization is now open for discussion, and I will ask a veteran road builder and a familiar figure at these meetings, Mr. James H. MacDonald, State Highway Commissioner of Connecticut, to introduce the discussion.

JAMES H. MacDONALD (State Highway Commissioner of Connecticut): Mr. President and Gentlemen of the Convention:—I have listened with more than passing interest to the discussion under the three different divisions into which this subject has been divided—the state, the city and the township—and the papers have been so very well presented, that I am reminded of the supposed story that you all remember of the two little fellows meeting each other and one had an apple and the other fellow didn't. One said, "Jimmie, give me a bite." "No; I won't give you a bite." "Then," he said, "give me the core." "Ain't going to be no core." (Laughter.)

I think the discussion has been handled so very well that there is very little I can say except perhaps, to relate a little of my own experience in regard to two of the questions that have been so ably presented. I have been to a great many of the conventions, it is true, and I have listened to the presentation of this great subject a great many times, and I think my memory serves me right when I say that I have never heard as able an address, or as able a presentation of this great question now confronting the American people, as the paper which was presented today at the opening of this meeting by the president of this association. It affords me a great deal of pleasure to make that statement.

The great difficulty that I find—and I have worked under the triple-headed commission quite as many years as under the single-headed commission—is that there is no such thing today as permanency in the commission. From my own personal experience, there is no such thing as stability, and I think, perhaps, Mr. President, that I am the oldest commissioner in point of service in the United States, who has served under both systems. The only stability and permanency that I know of is in the carrying out of the suggestion made by the president, and that is that each commissioner do all that within him lies in the limited time that he may have at his disposal as the official in charge of the work, and then let others take up the work that he has so well begun, and go on with it. There is an old verse which comes to me at this time, and it runs in this way:

"Right forever on the scaffold,
Wrong forever on the throne,
Yet that scaffold sways the future,
And behind it in unknown,
Standeth God within the shadow,
Keeping watch upon his own."

Now, that's all very well for Sunday schools and for religious instruction, but towns and cities and states are not run that way. We had a triple-headed commission, and it was run at that time, as we thought, in the best interests of the people;. and I think you will find, gentlemen, that each city and each geographical or political subdivsion of this great country of ours will be run in accordance with the minds of the people who reside in that particular town, in that particular city, or in that particular state, and run in accordance with the conditions by which they are surrounded. The downfall of the triple-headed commission in my state grew entirely out of the intervention of selfish personal interest, and for no other reason. I think I know the minds of the commission, and I did know them when we started in, in 1895, and when that great problem was presented to us, involving 15,000 miles of road and the population concerned and its great necessity, I know that we sat down and we carefully considered the problem and we determined the question by that study, as best we could at that time, but we found that the principal objection

was in the system that was employed. It was one-third state contribution money, one-third county and one-third town. We found that there was a county seat, and the county seat was contributing the larger share of the money. Of course, the county seat fellows felt that it was not right that they should be asked to pay more than their just and equitable share for the building of roads—they felt that they should not pay more than the other parts of the county. And so, after the first two years of the triple-headed commission, they came together and they wiped the commission off the slate and then they adopted the single-headed commission. I have been the commissioner for my state for some seventeen years, alone. It would have been very comforting to me, gentlemen, to have had brother commissioners with me to share the cares and the responsibilities and the burdens of the official obligation, but after sixteen years and over—and I think that I have borne my share of the burden and the heat of the day—I think I can truthfully say that had I the choice of the triple-headed commission or the single-headed commission for this great work placed in my hands again today—had I the choice between the two, I should say the single-headed commission. Get the man! (Applause.) Put the responsibility on him! Don't let him shirk it! Suppose he does go down in the strife? If necessary, let it be like that old, old story which we are told of Hector, who took each son, as they were closing in around him, and he put this one in, and he said, "One for Hector," and as the next one went in, he said, "Another for Hector," and another, and another, until the whole seven sons were thrown in, and then he said, "All for Hector."

In my judgment that is the position that every commissioner of today should occupy in his official place. He should be carefully selected because of his fitness, because of his honesty, because of his executive ability, because of his tact and because of his diplomacy—the qualities which go out from, or should go out from, the man carefully selected for the position. I care not whether his qualification is the callous of the hand or the diploma, so long as he is worthy and well qualified to properly fill such an administrative office. And I like that suggestion of the president, as well as the many points

that he covered in his able address. But I like especially the suggestion he made when he said, "Don't be ashamed or consider it unmanly or beneath your official dignity"—I may not have the exact words but that was the intent of the thing—"to go to some of the men who are working under you and take suggestions," for I have found many times, Mr. President, that there is a wide difference between the theory and the practice. I have found that in my work.

I like the idea of the whole discussion, and the subdivision of the topic, but of course, you can't do all these things at once. There's a wide difference between what can be done east of the Mississippi River and what can be done west of the Mississippi River. What we can do east of the Mississippi River, you can hardly start with west of the Missisippi. And so, I say that you will have to do these things just as we have done them over in New England, and I think what has been the experience of my own state has been the experience of the other states in New England. We started in with just a little clerical force and $75,000 of an appropriation, with a very limited list and a small population, and we didn't have as Brother Johnson says, that little checker-board plan. We had all those things to contend with. We had a saving, frugal, conservative people to deal with, and we had a new movement, but we had a people who, for nearly 300 years had been used to the township system of government, and who had seen their dimes go into the gutter and be washed away, week after week and month after month and year after year—their hard savings. And they decided that this great question should be taken out of local control and should be put into the hands of a commission to organize it in an experimental way.

And, in this connection, let me say that I don't believe you gentlemen ever have appreciated how much you owe to the state of New Jersey, the mother of this great good roads movement, for starting this great new thought which has led up to this whole idea. When I see delegates coming from one end of this country to the other to sit down together and discuss these questions—you may not all agree about them, but it shows a large interest, and I think I can see in your faces your purpose in coming to this meeting—I think I know the earnest purpose

that actuates you in coming here. Above all things don't handicap your states—don't handicap your commissions by loading them with too great financial responsibilty. Give them an opportunity to get acquainted with and find out what other states are doing and to carefully investigate these questions, so that they may go into them and get acquainted with them—with the great work that is to be done all over the United States. Then, as a result of that kind of investigation, which of necessity must be somewhat extended, will grow this system which has been so ably described by my friend Major Crosby. We started in on that plan, and we worked it out gradually. The little towns had to pay first one-third, and then one-half. And then, as the state saw more benefits which were to accrue to the state as a state builder and because of the increase in the population and in its financial condition, she saw she should go into it not by way of making an expenditure for highway improvement but as an investment, and she saw that the better the roads were built, the better the returns would be, and further, that if we were to do anything, that it should have a degree of permanence that would take care of itself for all time and not leave the future generations an obligation or indebtedness that they would have to pay.

As to this question of repairs, we have an annual appropriation which takes care of all of that, day after day and week after week and month after month, so that as future generations come they will simply accept the obligations that would naturally come to them in the discharge of their own responsibilities. We have our own system for doing all the repairs under the splendid plan very early adopted by the Massachusetts Highway Commission. We have our own repair man who has charge of the repairs; we have our own superintendent who has charge of all the repair men. We have a man in charge of this great question of oiling, and we have our chief engineer and our great corps of assistants to him, and then we have them all under the commissioner.

But there are things, gentlemen—and I think perhaps I ought to say this because perhaps it may be the last time that I can address this association, and so it seems highly proper that I should say this at this time because of the fact of my early association with you—I think

I ought to say at this time that the commissioners who are in the service today, if they are fearless, if they are honest, if they are competent, if they serve the people, as a compensation they should receive the support of the people. They don't as a rule receive the support which they should receive. I don't speak for myself particularly, because I have always received a substantial backing from my people; they have given me their confidence in no uncertain way, placing in my hands millions of dollars; but I know that commissioners as a rule are not so supported. I do know that in the great whirl of active business life, the men who are using our roads, sometimes constantly, if you please, are very quick to criticize, and very slow to commend. And I do believe that what we want in this country in taking up this great question, is the cooperation of the people. The people can lift up the hands of the commissioners and not only of the commissioners themselves, but of their subordinates, as well.

And as I started in on this question, so I wish to reiterate—that there is no permanency in our form of government. The insiduous, gradual working into our system of that which in our form of government is inevitable, politics, precludes the possibility of any man, no matter what he may be, either in a subordinate position, or in an official capacity as the head of the movement, from long taking charge of that particular work that is placed in his hands. But at least we can do this: To the limit of the ability that we may have we can do everything that within us lies to bring about a perfected system, building deep and wide, and with a thought for the future, that which we do; and then let the future take care of itself. (Applause.)

PRESIDENT LEWIS: I told you this morning that we had hoped to hear from the representative of another country, but he had not yet arrived. He is now here. He represents, perhaps, the pioneer of modern road building nations, a country where the organization and methods of administration are very different from ours, in that they have a centralized department, working through a corps of engineers of roads and bridges. I am sure you will be interested in hearing from a representative of that country, a man who is the Director of the French Mission

of Engineers to the United States. It is a significant fact that the French government maintains a mission of engineers in the United States, and has done so for about two years. I take great pleasure in presenting to you Monsieur J. de Pulligny, Engineer-in-Chief, Board of Public Works of France, Director of the French Mission of Engineers to the United States.

JEAN DE PULLIGNY: Gentlemen, you see I have an excuse for taking a part of your time, and my good and eminent friend, Mr. Lewis, has explained to you the reason for it. He thinks you would be interested in a comparison between the excellent methods which have been proposed to you in the papers which have been read, and the French system of building roads. I can do that very shortly and very quickly.

On the organization which has been proposed to you for state road building purposes, I shall say nothing, because in all its general lines, differences in the circumstances being considered, I may say that the organization that has been proposed rests on the same principle that we use ourselves in France. But what I compare with your state is not strictly speaking our general French state; it is what we call our department. So that, the comparison, like all comparisons, is not quite adequate, for the French department is smaller than your American state. The French department would be more like a division including three or four of the counties in one of the older states say, for example, Massachusetts, so that, the state of Massachusetts, composed, I think, of twelve counties, would make up three or four French departments.

The basis of the road organization, of the road system, in France is the department. We have very fine roads which are called the national roads, and which you would call in America the federal roads, and are in charge of the general state, but we have fourteen times more in length of roads that are not national and that are under the administration of the department, and that's the most important part of our system for you to know about for purposes of comparison. A moment ago one of the speakers before you, Mr. Johnson, made a very interesting calculation to show that about between 15 and 20 per cent. of the roads ought to be state roads. I don't think the principle on which his calculation was based is quite the same as we

have in France. To decide which roads shall be managed by the department and which roads shall be administered by the township, we do in a different way. As I understood it, he spoke roughly of two roads at right angles to each other, going through the townships to the centers. Well, in France the practice is wider than that. It is much more comprehensive. It has been determined that when a road interests more than two towns it can't be administered by either of them. It is not just that it should be so, because if one of the towns constructs its part well and maintains it properly, and if the other town opposite does not do its own part in the same manner, then the first town suffers an injustice. So it has been determined that when any road interests more than one town, it must be managed by the department. It is managed partly with funds which are provided by the town, but it is managed by the department, which adds a certain fund, a certain contribution, to the expense.

You must remember that it is not just to compare the French department with your state, because your state is much bigger. It is not just, either, I expect, to compare the French village with your American town, or the village districts which we call the "commune," with your American township, because, I think—I may perhaps be mistaken—but I think the French village is often much smaller than any of your American towns. Some French villages which have even a little locally-elected body, and a mayor and a church, do not number more than 500 inhabitants, including men, women and children. You will see they are very small towns. That little town has certain of its roads or streets—you may call them as you wish—which interest the town only, and which do not serve for traffic between two villages. Those little roads or streets, that village can manage as it wishes, but the other work, as I told you, is administered by the department.

In each department you will find an organization with the chief engineer at the head and with assistant engineers under his orders, and in each district, corresponding to a county, one assistant engineer with district engineers and other assistant engineers, and finally with a foreman, and at the end with a patrolman, who stays on the road with his wheelbarrow, his ax, his pick and his shovel, and

takes care of and cleans the culverts and cleans the ditches on the side of the road, so as to keep the water off the road, and makes quickly any small repair needed, before a large one be required. That is the organization of the department, and that organization is the same in every district. There is a man residing at the capital of the department; there is an assistant engineer or foreman under his orders residing at the capital of each division. There is an assistant residing in each capital of what you might call a county, and the county is divided again into districts, having each a little capital, and there is a man residing at each one of these, so that finally there isn't a square yard, or a lineal yard, of road in France where it can not be said: "That square yard is under the direct responsibility of Mr. So and so, who is the patrolman; it is also under the responsibility of Mr. So and so, who is the chief patrolman, that is the foreman, you understand. It is also under the responsibility of Mr. So and so, who is residing in the little capital of the district; it is also under the responsibility of Mr. So and so, who is the engineer residing in the capital of the county; and it is also under the responsibility of Mr. So and so, who is the chief engineer and who is residing at the capital of the department. So, you have a direct and certain responsibility, you see. If there is a hole in the street and a cart falls into that hole and is broken, all of those who are responsible can and do get a good scolding. (Laughter and applause.) And, it is expected that it will not happen again.

So that, those common roads in each township are administered by that force of the department; and the township is not free to accept it or not—it is obligatory. But after these roads or streets, as you wish to call them, have been taken from the government of the local township, there remains a certain number of streets or roads, which interest the village only. Well, for these, the village council generally asks the prefect, who is the political chief, or, as you would say here, the governor—they ask the governor to take care of those roads also, with the force of the department at the expense of the commune, and for that the township allows a small fee to each agent. So the department takes care of those little pieces of roads, too. Now, if it is a large city—instead of being a village—if besides its streets, it has got a certain number of munic-

ipal buildings to take care of; if it has a few sewers; if it has a little waterworks; if it has gas or anything like that—well, all that put together is enough municipal work to have a man to properly attend to it, and that man usually attends also to the city streets. That is the system.

Now, I told you that the department took the maintenance and the construction of the roads out of the hands of the town which has a little elective magistrate of its own called the mayor. They take that out of his hands, but the town gets a very substantial compensation for that loss of liberty—a contribution from the department for the new roads. The town doesn't get any contribution for the maintenance of the roads which belong to it. For that maintenance it is obliged to raise taxes and it has the right to do so, and those taxes have to be approved by the prefect, but the maintenance of the roads must be furnished by the town. But, for new road construction, the department gives a contribution which may be high if the city or village is poor. And in a case where a village is quite poor, where the revenue tax produces only a small sum, or where the village district being large it is necessary to undertake the construction of long roads and expensive ones, in that case the contribution of the department may amount to as much as 85 per cent. of the value of the new roads. You see how high is that contribution.

One more thing I will tell you before I leave the platform. All the preparations, all the designs for new roads, all of this scheme for maintaining the existing road, all of that is prepared yearly by the same force of engineers. It begins with the small resident engineer, who is in close touch with the local people and makes up the claims of the township—that it is necessary to do this, or it is necessary to do that—and he shows the general scheme for all his districts and sends it to the man who is resident in the county. That engineer goes over everything, every one of the plans, scratches off certain propositions, etc., does the best he can with it according to the finances of the department and the necessities of the district, and sends the proposition to the chief engineer in the capital of the department. That man again makes a new work of it, if necessary, scratching off what is not wholly necessary, etc., and then presents the proposition to the legislature of the department.

That legislature is smaller than your state legislature, but it is an elective body—it is representative of the people. In that body, every man has got a little special interest for his district. Every man in that legislature represents one part of the county and doesn't represent the other, and all these men go on very carefully and in detail through the chief engineer's proposition and every one tries, as we say in France, to pull a little of the blanket on his own side (Laughter); but then the others will pull the blanket also, and so there results, under the direction of the chief engineer—who is unprejudiced and independent—there results an equilibrium, and in that way results the proportion which is put on the shoulders of the department and the partial proportions which are put as burdens on each township, and all the scheme is designed with justice and all work done with efficiency. (Applause.)

PRESIDENT LEWIS: I feel quite sure, gentlemen, that you appreciate this description of the French organization, and we are grateful to Monsieur de Pulligny for what he has said to us.

The question of organization is still before you for discussion from the floor.

COL. E. A. STEVENS (State Highway Commissioner of New Jersey): Mr. President, I wanted to emphasize the point made by Monsieur de Pulligny and perhaps state it a little differently. That is the fact that the tax paying ability of the community bears no rational connection with the load placed upon its tax funds by its roads. If you will stop to consider a moment, you will very readily see that point.

It is very possible that we have in New Jersey, for instance, a large number of very important roads running through very thinly settled and very poor country; and yet under our system that has been worked out, the responsibility for maintaining those roads rests upon the local community. And it very often works a great injustice and one that should be met in any system of administration, because, after all, the financing, the providing of funds, for making "the old mare" go, is a very important part of your administration.

Just exactly as we work in almost all the states our public school system, upon the fundamental principle that the education of every child in the state is a matter of impor-

tance to the state at large, so, perhaps, in a lesser degree the condition and proper maintenance of every mile of road in the state is of interest to the state at large. It seems to me that this principle and the fact of the injustice that is worked by any other principle, should be recognized in our administration and in our taxation. It seems to me that the funds to be provided for road work should be levied by some general tax based upon valuations—upon the total amount of ratables in the state—and its expenditure should be based upon the road mileage, of course varied as to the classification of that mileage, according to the importance of the road. That is practically what they are doing in France. It is merely repeating M. de Pulligny's statement with that thought added to it. We are doing that in New Jersey, and I think that we are doing it in most of the other states in reference to the public schools, and there is no reason why the road men should not take a leaf out of the book of our public educators.

It is very simple to go on from the matter of raising a fund to the method of spending it, and follow likewise the practice laid down by the public schools. New Jersey, and, I believe, most of the other states, require in the distribution of their state school fund that the communities and those in charge of the local schools, shall live up to a certain standard—employ teachers whose qualifications are set and determined by the state authority and provide schoolhouses and apparatus up to the state standards. In New Jersey there is a very simple method of enforcing these rules by withholding the state funds unless they are complied with, and complied with very strictly. In the same manner, it seems to me that the men who should be, and who are not, today in charge of every square yard of road surface should be qualified men, whose qualifications should be set and passed on by the state authorities. I simply want to throw out that idea as a suggestion. Perhaps it is difficult to live up to at present, but we may be able to come up to it in time.

P. W. SPAULDING (Evanston, Wyo.): Mr. President, the gentleman who just preceded me has remarked somewhat on sparsely settled districts. I don't know of any that are more so than those in our state. But while our state is only sparsely settled, yet it has sent eight or ten of its citizens here to this convention.

We have a state about 275 miles wide and 400 miles long, and the county in which I live, one of our largest, with a population of 14,000 people, spent during the year 1911, $29,000 on roads, and we have spent this year, $54,300 so far. That shows what we are doing with our small population. Last night in the city of Chicago I talked with Attorney General Barnes, of the State of Utah, who was there, and who wanted to come here but couldn't and he told me that this year that state, with about 300,000 population, is spending over $1,000,000 on its roads. I think that is a good showing for the West.

My object in speaking to you at this time is that I think this convention should broaden out. I think we should go beyond our township limits; I think we should go beyond our county limits; I think we should go beyond our states—I think we should take an interest in the national movement that is now being inaugurated for good roads. You must all be familiar with what our next congress will probably do. It will probably take some steps for the establishment of national highways, from ocean to ocean, from Canada to the Gulf—highways that will not stop at a state line, highways that will not stop at a county line or a township line—and I think that we are interested in those highways; that we all want them. We want you people in the East to come out and see us, but we don't want you to come out as the congressman from here did who came out on a walking trip, but we want a road through so that you can come out in your automobiles and enjoy yourselves.

Four years ago I went from Evanston, Wyoming, to New York in an automobile and all across western Wyoming we rode with shovels in our hands, fixing the bad places every little way, so that we could get over the road. The conditions are now changed. We have so improved the roads across the Rocky Mountains in our state—and I will say that our eastern state line is on the eastern side of the Rocky Mountains and our western line is on the western side—we have so improved those roads in the last four years that you can go from Ogden, in Utah, to Cheyenne or Denver, or east of us, without getting out of your machine on account of road conditions. (Applause.)

Now, I have told you the size of our state,—we have

about 140,000 people in the state, but we have distances of 80 or 90 or 100 miles between our towns. My town has about 3,000 people. The first town east of us is Green River, 101 miles away, and with 1,500 people—and nothing in between the two. We are spending all we can, but we can't spend enough, and we need and we should have national aid; we are just typical of some of the sparsely settled communities in the South, in Virginia and in Tennessee and in the Allegheny Mountains. They can't themselves do all the road work which will make one complete highway. But they need and we need aid from congressional sources; we need some of this money that is going for harbors and waterways, which are not used. I think that this convention should in its resolutions memorialize the matter to Congress—that it is the sense of this convention that these communities have some national aid, either by helping us to do the work, or by the establishment of a system of national highways. (Applause.)

PRESIDENT LEWIS: Is there anybody else who has anything to say on this subject. I had hoped to hear from Mr. McPherson, of Saskatchewan, this morning, as a representative of one of our sister countries. He is now present and I take great pleasure in presenting to you, Mr. McPherson, the Chairman of the Highway Commission of the Province of Saskatchewan.

A. J. McPHERSON (Chairman, Board of Highway Commissioners of the Province of Saskatchewan, Regina, Sask., Canada): Mr. President and Gentlemen of the Convention:—I take this opportunity to express my pleasure in being with you at this convention. I represent a province in Canada, in the Canadian Northwest, where development is taking place, and where we are starting everything, and naturally, you will gather from that, that I came down here to learn something.

We are in about the same position that many of your states were 150 or 200 years ago, and we are trying to start in on work and do it in such a way that we will come to the position that you occupy in a shorter time than the 150 or 200 years it has taken you. It might be interesting—in view of the papers that have been so ably presented to you—it might be interesting to describe how the commission system in Saskatchewan has been worked

out in the last year or two. I happen to be the chairman of the commission. Instead of our commissioners being elected they are appointed by the government. The government is responsible for practically all the officials, all the executive officers, and the commissioners are appointed. The commission consists of three commissioners, but two of those commissioners practically act in a general capacity to advise on principles and on policies, and one commissioner has the executive duties to perform. It is more or less based on the practice that has been so thoroughly worked out in connection with corporation control, whereby you have a board of directors and one managing director on whom all responsibility is centralized. Then the organization below that is, I think, similar to your own, except that I think all the men are appointed instead of being elected. We have a chief engineer and division engineers under him, and the resonsibility merely goes down, limited by the degree of responsibility that is thrown on the minor officers.

Regarding the division of work: We have two different organizations that are attending to the construction and maintenance of roads. One is the government and the other consists of the municipalities—urban and rural municipalities. The government's policy is more less in the nature of assistance to municipalities. We do work in two or three ways. First of all we have our roads laid out in a system somewhat simillar to that which Mr. Johnson described. We don't recognize township boundaries; we take the market points—the objective points of traffic—and run lines directly out into the country from those points to the four cardinal points. Those are naturally the roads that collect the traffic, the ones on which the heaviest traffic will be found. As much as possible the government tries to confine its expenditure to the construction and improvement of that class of roads.

Another class of roads which the government finds it an advantage to undertake, are the roads in sparsely settled districts, such as the last speaker spoke about. There are large sections of the country that are more or less rough, and where settlement is sparse. We have other sections that are thickly settled, where railroad development is just taking place, with long distances, just as our friend from Wyoming has spoken of, between the towns

or settlements, and we need roads through those places, where for miles and miles there will be nobody living at all and nobody paying taxes. One of the principles we apply in road building for the assistance of local traffic is to recognize that state of affairs and assist the municipalities—or do the work for them, which amounts to the same thing because it relieves them of trying to do the work in places that are beyond their means. Then we try to have the local municipalities recognize that it devolves upon them to construct and maintain the branch lines leading into these main roads. We find that it works out into a system in which our own main roads are the backbone. When the branch lines come in they naturally form a system that serves the district and the population of the country in the best way.

Another point in connection with this thing: We recognize that any successful system, under a commission or in any other way, must depend on public opinion, and our condition is very much such as Mr. Johnson described, where the local authorities more or less squander their funds, and where they do their work as payment of taxes and don't get the best value for their money. We try to bring an educative influence to bear upon the local municipalities by assisting them to the extent that they are unable to assist themselves. We have succeeded in getting quite a number of municipalities to start in and organize and equip themselves and build roads during the year, with an organization that builds roads to the exclusion of other interests. We find that in those cases they do it just as well as it can be done. The men get very expert after working a short time on the roads, those localities get far better value for their money, and where they are doing that kind of work we have no hesitation whatever in using their organization to build roads. Naturally they like to spend our money on their roads in that way, and since they are doing it in the way that we would spend it ourselves, we are simply getting the benefit of their organization. There are some advantages in our case that might not apply in all cases, because there's so much work to do that it is limited by the number of people we can get to do it—the number of people that are available to work on roads—rather than the limitation of money or organization. I might say, as far as

the country itself is concerned, that we have somewhere near 500,000 people in Saskatchewan, and we have a country that is, within the area that is settled, about 500 miles square, with 250,000 miles of road allowance in that area. The settlement is pretty well scattered over the territory, so that a great part of that 250,000 miles represents the need of some sort of improvement, and naturally a good deal of our work, therefore, must be more or less of a colonization nature.

I think, gentlemen, it is likely that all this will give you some idea of the work that we are doing up in Saskatchewan in the road business, and also a little idea of the way in which an attempted organization worked out this summer. It was more or less of an experiment, but it seems to me that we have applied the principles that have been described here, and whether on account of the study that we gave the question, or by chance, we have steered clear of some of the rocks on which our friends tell us we might have failed.

C. GORDON REEL (State Superintendent of Highways of New York): Mr. President, as I looked over the program, I thought some attention would be paid to this question of federal aid, or that the question might be dealt with in some of the regular papers, but as I see no paper touching on this question of federal aid, it seems to me opportune to present one of my own. As you know, there is a very strong agitation for federal aid, and the coming Congress, in all probability, will take some definite action in that regard, and naturally, we are all very much interested.

The chairman of the Senate Committee on Post Offices and Post Roads, Senator Jonathan Bourne, has sent the states maps, on which he wants indicated certain roads out of the total mileage, upon which we would like to have federal aid. Now, in a state like New York, when you come to take that up you find that about all the roads upon which you naturally want federal aid, are comprised in your state and county systems and I have written the senator again just how to proceed in that case. But what I wanted to say was this: Our friend from Wyoming has invited us out there in our automobiles, but whether we go to Wyoming or not, this question of federal aid, it seems to me, has got to be absolutely

handled along the same lines suggested by M. de Pulligny as the method of administration in France, and that is, the states themselves must contribute. It would be enormously unfair for a state to receive federal aid under some federal aid scheme, unless that state in turn, to some extent at least, contributed substantially itself, and I think that since this matter of federal aid is going to come up and be in everybody's mind, we ought to remember this principle, and if federal aid is a feasible thing, it should be established on the principle that the states that receive federal aid must contribute their proportionate share locally, which, in turn, will be supplemented by the federal government, and that is the thought which I want to suggest at this time.

PRESIDENT LEWIS: I want to call your attention to the fact that one entire session is to be set aside for topical discussion. Tomorrow ballots will be distributed in this room, and you are all requested to indicate on them, your first, second and third choice of subjects for their discussions. There are eight subjects to be voted for, and one of them is, "Division of Expense of Road Improvement over Town or Similar Local Unit, County, State and Nation." So that there will be an opportunity then, if you wish, to bring up this subject for formal discussion.

MR. SPAULDING: I was just going to state to the convention that the interest that our state is taking in the cause of good roads, is on account of the large amount of automobile traffic that is now going through the state. In 1908, the first family tour in an automobile was made from coast to coast, and that was made in some thirty-one days from Los Angeles to New York City, and was made in the first part of the month of May. Since then, it has been increased gradually until it has reached large proportions.

And it has not been our own people who have been going through, but it has been the eastern people, from the Missouri River points, from Massachusetts, from Ohio, from Indiana, from New York—from all of your states back here. One night last summer at Evanston, the town where I live, there were fourteen different automobile parties who were going to the Pacific coast, and they were all going without trouble and without road inconvenience.

And I think that the extent of that traffic will be greater next year, and the next year it will be greater than that, and with the Pacific Coast exposition at San Francisco and in Southern California, it will be much greater than ever before. I think with all that traffic, and with the broadening out that has been going on among us along the line of good roads, that we should have the help of the federal government so that we can improve road conditions beyond the lines of state boundaries. I told you of the amount of money that our small population has spent, to show you that we are doing our share; I told you of the million dollars that the state of Utah has spent, to show you that Utah is doing its share; and that is the reason for the agitation for federal aid. We are not able to do it all; we are not able to give you the roads that you ought to have; we have given you the best we can do, roads that you can get over without any trouble—but we must have help to give you the kind of roads you should have, and that is what we are asking.

PRESIDENT LEWIS: Is there any other discussion on the subject—not federal aid, but organization? Federal aid will be taken up on Friday, if you so elect. The subject for this afternoon is organization.

A. R. HIRST (State Highway Engineer of Wisconsin): Mr. President and Gentlemen:—I am not going to talk about federal aid. But it may interest this convention to consider the organization of one of the newer states that has taken up the idea of state aid, and that is the state of Wisconsin. We have not only a large state, but a state of diversified interests as well, with counties varying from thickly populated ones to counties almost as bad, from the standpoint of population, as some of the counties in the state of Wyoming.

We have this year operated the first time under our new state aid system. Our commission, differing somewhat from other commissions in the United States, is a non-paid commission, consisting of three men, appointed by the Governor; and two ex-officio members, one being the State Geologist and one the Dean of the College of Engineering of the State University. The men appointed by the Governor, are appointed for six years, and one of them is reappointed every two years, so that we have a commission that can hardly be radically changed by any

political cataclysm. The members of the commission are paid only their actual and necessary traveling expenses, and they meet about once a month. The engineers appointed by the commission have immediate charge of the work.

Each county in the state is required to lay out a system of roads comprising not over 15 per cent. of the mileage in the county, radiating generally from the county seat and market towns; and those roads, furthermore, must be connected at the county lines with the systems of adjoining counties. The law provides that when any town in the county—and we have 1,195 towns in the state—votes an amount not less than $400 for the improvement of any portion of this system of roads, the county must appropriate an equal amount and the state an equal amount. If the county wishes to disregard the towns and act as a county, the counties may improve their roads, paying two-thirds of the cost and the state one-third.

We have an annual appropriation of $350,000 which, when made by the Legislature, was thought to be ample to pay one-third of the cost of all construction. During the first year, the towns in the state and the counties in the state, voted a total of $450,000, and we constructed—or should have constructed this year, if the weather conditions had been more favorable—about $1,250,000 worth of roads and bridges in 500 towns, in 65 counties. For next year, nearly 900 towns out of our 1,200 have voted a total of $860,000, and if the state aid were sufficient to pay its full share, we would build about 1,400 different pieces of road in 900 towns, in 68 of our 71 counties, and about 325 bridges.

The remarkable feature of the work in Wisconsin is not the amount available for the work; there are many states that are spending much more money. It is the fact that we are operating in so many small units. The problem of building $2,500,000 worth of road is not a large problem, if the road is being built at the rate of from $12,000 to $15,000 a mile and in stretches of several miles; but when a town votes $1,000 and asks us to build two or three pieces of macadam road with the $3,000 available, it becomes quite a problem. The representatives of the older states in the East hold up their hands in holy horror, because they think that the thing cannot be done. It can be done and done properly, and I want to say,

gentlemen, that we are going into every town in the state and build something better in that town than has ever been built before. It may not be a perfect road; we do not claim that it is. But we are building, for about $3,000 a mile, roads good enough for our people, and we believe that the 1,400 examples of fairly good construction that we will scatter around the state of Wisconsin next year, will have a greater influence upon road sentiment and the road development of the state than if we built only 200 pieces. Those are the principles that we are working on—differing quite radically from any other state.

The roads are built by the county highway commissioner in each county, nine-tenths of them under the day labor system. The actual control of the construction is in the hands of the county highway commissioners. We, in most cases, prepare the plans, and inspect the work from time to time, but the direct responsibility is on the local communities. It is awfully easy—and it would have been easy for us—to adopt the eastern system of having the town, the county or the state, put in large amounts of money and build a certain few pieces of road; but I believe that the system of distributing these roads, even though they may not be perfect roads, and of giving each man in the state an opportunity to travel on a piece of this road, not 15 years from now, but today, has had more influence on the rapid development of road building sentiment in our state than any other thing we could have done.

Five years ago, when we first started in Wisconsin, there wasn't a steam roller owned by one county in the state, and there wasn't being built in the state of Wisconsin, 10 miles of permanent road in a year. Next year, we will build 600 miles in about 800 towns, and there will be engaged in this road building work in Wisconsin at least 150 complete outfits owned by the counties. We have practically given up the contract system, simply because no contractor worthy of the name would take jobs so small, but we have found by planning our work systematically that we can build these roads and keep them down to a very reasonable figure as to cost.

The cheapest job that we built this year was a macadam road with stone surface 9 ft. wide and 24 ft. between ditches, at a cost of $1,300 a mile. It sounds astounding, but the contract price for collecting stone, crushing it and

dumping it on the roadbed ready for spreading, was 60 cts. per cu. yd. So, it is entirely possible. On the other hand, we are building just as expensive roads in the state as are being built in any state. We have one county in the state in which we will do $400,000 worth of work next year, getting about 30 miles of road for the $400,000, so that you see we have all kinds.

There is one part of our scheme that is different, I believe, from that of any eastern state, and that is this, that the state gives aid in the construction of dirt roads. That doesn't mean that we will run a road machine or a King drag over any number of miles of road in a town, but that if a town has a bad hill or a bad marsh, or a place that needs widening—some specific dirt road problem of some importance—we will go into that town and build a piece of dirt road without surfacing it. In order to get all the towns in, if they don't want to build a piece of macadam or gravel road, or if they don't want to cut down a hill, we allow them to build a bridge or its approaches with state aid money.

The state levies a tax of about one-tenth of a mill, which produces $350,000. We expect to have it made a million dollars next year, and these taxes are levied on all the counties, so that the county that contributes its share in this way, doesn't like to see its neighboring county get the benefit of its contribution, and so it comes in, and then, two or three towns in that county will come in, and the result is that other towns in the county find that they are helping to pay for roads in those towns that have come in, so that while five years ago, we were doing practically no work in the state, next year we will be doing some kind of work in 900 towns. We are working from the bottom up, and I sometimes believe that a good many of the state highway schemes have started too far toward the top, with too little control over the work by the people who are really paying for it. And I don't believe it hurts any of us to be directly responsible to the people themselves for the work that we do. If it is good work, we will get what belongs to us; if it is bad work, we will get "fired."

I think that on the whole we have a remarkably healthy and widespread movement in Wisconsin. And I want to say one thing further and that is this: We have

a lake district in Wisconsin which is second to no lake district in the United States for attractiveness as a summer resort, and the state of Wisconsin expects to soon build a road from the Illinois line to the lake district, and we won't ask national aid for it. And if automobiles come into the state of Wisconsin by the thousand, let them come; the state of Wisconsin can well afford to build the roads to make it easy for them to come there. (Applause.)

JOSEPH W. HUNTER (Deputy State Highway Commissioner of Pennsylvania): Let me give a word of encouragement to the gentleman from Wisconsin and his work. Ten years ago next January the state highway department of Pennsylvania was first organized, and it was done practically along the same lines that the Wisconsin work has been started. It was the quarter-mile stretch, the half-mile, the three-quarter-mile and the mile, built in the several sections of the state in the eastern and in the western parts of the state, and in the northern and in the southern parts of the state, that made possible the organization that we have today, under which the state has taken over about 8,000 miles of the township and county roads and has started to build those roads as state highways, solely at the expense of the commonwealth. It was the little lesson here and the little lesson there that made possible the greater organization of today, and I believe that these object lessons scattered around over the state, count more than any other thing you can do to get your people interested in state aid for highway improvement.

THIRD SESSION

Wednesday Forenoon, December 4

PRESIDENT LEWIS: I have asked our First Vice-President, Mr. Harold Parker, to preside at the sessions today. He is a former president of the Association, and you all know him. He needs no introduction. (Applause.)

CHAIRMAN PARKER: Gentlemen, I realize that I cannot keep you in as good order as Mr. Lewis, but Mr. Lewis is suffering from a severe cold, and he has asked me to take charge of the meetings today in order that he

may repair the injury that the Cincinnati weather has produced upon his throat. With this introduction, gentlemen, I am going to proceed at once without delay to the consideration of the matters that are on the program; and we intend to keep just as near the program as it is possible to do, because there are a great many things to be considered and there are discussions which may take up a greater or less space of time.

The meeting this morning will begin with a discussion of "Bituminous Pavements for City Streets," by Mr. Tillson, whom all of you know for his reputation in this sort of thing. Without further introduction I am going to ask him to present his paper.

BITUMINOUS PAVEMENTS FOR CITY STREETS

By GEORGE W. TILLSON

Consulting Engineer to the President of the Borough of Brooklyn, New York City

Although the subject would permit it, the author does not intend to discuss any of the coal tar pavements of the past, but only the bituminous pavements that are considered standard today.

Probably no pavement material that was ever presented to the United States was received with such favor as was asphalt. It came at a time in the early seventies when the Eastern cities of this country had become tired of the old rough stone pavements that had been used for many years and the young and progressive cities of the West were demanding new pavements, so that but a very slight demonstration was necessary to have its true merits appreciated. It made a smooth pavement, one easily cleaned, pleasant to look upon and pleasant to ride upon. Its cost could be ascertained, and its durability seemed to be the only unknown element in its character. To overcome this the early promoters agreed to lay the pavement with a guarantee to keep it in repair five years without any expense to the municipality. Just why this term of five years was adopted is not known; it was a perfectly arbitrary one, but experience has seemed to demonstrate that the decision was just, as many asphalt pavements have been laid and done good service for two, three or even four years, and in the fifth or sixth failed almost entirely.

When this pavement was first proposed, very few people, comparatively speaking, had even heard of the term asphalt, and it was impossible to obtain any definite information regarding it. It could be learned that the material was obtained from the Island of Trinidad, somewhere in the Caribbean Sea, but of its properties or value no information could be obtained. At the present time, while examinations of and experiments with this material have been going for the last thirty years, very few chemists wish to make positive statements regarding it.

The word asphalt is considered by chemists as being an indefinite term, not defining a specific material, as it is considered to be an occurrence rather than a substance, it being composed of bitumen and certain other foreign matters. Bitumen is defined by the chemists in a complex way, but in asphaltic specifications generally as that part of the asphalt which is soluble in carbon bisulphide.

Time will not permit, nor is there necessity for a discussion of its origin at the present time. It is known definitely that it is a mineral product, widely scattered over the world and found in many states of the United States. The hard asphalt was undoubtedly formed by distillation occurring in nature's stills for years and perhaps centuries, and the principal places from which it is obtained seem to be furnished from an inexhaustible subterranean supply.

The first asphalt pavement of any quantity in this country was laid in 1877 on Pennsylvania Avenue, in Washington, and since that time it has been in general use all over the country. In 1890 in the eight cities of Boston, Brooklyn, Buffalo, Chicago, New York, Philadelphia, St. Louis, and Washington, there were 246 miles of asphalt pavement. So great was its popularity that in these eight cities in 1911 there were 2,348 miles. This seems an enormous growth, but simply shows how the pavement met the demands of the people. In the Borough of Brooklyn at the present time probably four-fifths of the petitions received for new pavements which are to be paid for directly by the property owners on the streets are for asphalt, and this borough on October 1, of this year, had 482 miles of asphalt pavement out of a total of 766 miles.

The first pavement laid in Washington was of Trinidad Lake asphalt, but its success was such that other contractors made investigations in different localities, so that

it was not long before other kinds of asphalt were presented for use; and it is probable that there has been more litigation in connection with asphalt and asphalt pavements than with all other paving materials combined. These were first between the so-called Trinidad Pitch Lake and Trinidad land asphalt; then between Trinidad and Bermudez; then between Trinidad and Bermudez and California asphalts; then between the natural asphalts and the oil asphalts; and at the present time the discussion is about the relative merits of the different oil asphalts.

As has been said, the hard asphalts have undoubtedly been formed by natural distillation of oils. In the refining of the petroleum oils of California, it was discovered that, after evaporating the volatile oils, an asphalt residuum was obtained. These California oils are different from the Ohio or Pennsylvania petroleums, as these latter when distilled produce paraffine rather than asphalt; consequently the Eastern oils are said to have a paraffine while the California oils have an asphaltic base. Similar oils to these latter have also been discovered in Texas, Mexico and on the Island of Trinidad.

From these different oils satisfactory asphalts for paving materials have been made. It is necessary, however, that the distillation of the oils should be carried on carefully and with certain restrictions so that the valuable constituents of the asphalt shall not be taken away. In other words, the distillation should be made with the understanding that the asphalt is the main product to be obtained and the volatile oils the by-products, rather than the volatile oils should be the main product and the asphalt the by-product. With proper stills and proper attention to the process, good paving asphalts can be obtained from the before mentioned oils.

It is extremely difficult to tell by physical and chemical examinations whether any asphalt is suitable for paving purposes, as there is no definite standard for same. Asphalt pavement, as is well known, is composed almost entirely of sand, and what is wanted is a substance that will hold these particles of sand together so that the resulting pavement shall be as resilient as possible and also withstand the great changes of temperature to which all street pavements are subjected. As most asphalt pavements are laid in a continuous sheet, this latter quality is very important.

Trinidad asphalt being, as has been said, the first asphalt that was used for pavement, and having been found to be successful, it was natural that any other asphalt proposed for use should be compared with Trinidad, and if it possessed the same characteristics it would be a logical conclusion that it would make a good pavement. Bermudez asphalt, which in addition to Trinidad is about the only natural asphalt that is being used today, is also to be considered standard. But these asphalts, while they both make good pavements, have different characteristics. Yet it is probable that the best method of examining a proposed asphalt at the present time would be by comparing it with either of these two mentioned above.

As the demand for asphalt pavements increased and it was learned that good pavements could be laid with an asphalt distilled from California oils, they have been used to a great extent and with satisfactory results, as have those from other oils.

The natural asphalts, that is, those which have been distilled by Nature, are too hard for direct use in pavements and must be fluxed with some softer material. The quantity to be used depends upon the character of both the flux and the asphalt and also upon the conditions under which the pavement is to be used. Just what is the most desirable flux is difficult to say, as probably one kind would be better for one asphalt and another for a different one. It would seem logical that if the bonding material is asphalt an asphalt flux should be used, but when it is known that the oldest and some of the most successful pavements have been laid with a paraffine flux, it would seem unwise to prohibit its use. This mixture of asphalt and flux after it is prepared for the pavement, is known as asphaltic cement, and as this is the material to be actually used it has been thought by many that specifications for asphalt should specify tests for the asphaltic cement without any regard for the asphalt itself. In the present stage of the industry it would seem to the writer that this is hardly a safe proceeding. Many tests are now being made on the asphaltic cement, such as penetration, ductility, susceptibility to changes in temperature, brittleness, specific gravity, etc., elaborate machines for which are in use, and while it is undoubtedly possible to test an asphaltic

cement and be sure that it will make a satisfactory pavement when tested, the author knows of no tests that can be made which will demonstrate its character in ten, six or even five years; the idea being that a natural hard asphalt may possibly be fluxed with a certain material so that it will make an asphaltic cement that will be satisfactory in every way at the time it is made, but when laid upon the street and subjected to the action of the atmosphere the lighter parts of the flux may volatilize, so that the pavement will crack so badly as to be not suitable for general use.

It is possible that by using accelerated tests, continuing the same to destruction, and that by comparing these tests with similar ones made upon the well known asphalts, satisfactory results can be obtained. The writer feels, however, that at the present time it is better to have a knowledge of the original asphalt.

In the manufacture of the oil asphalts it is only necessary, so far as use is concerned, to bring the asphalts to a suitable consistency for paving, but an asphalt of that consistency is so soft that it is not easy to handle, and consequently the asphalt is sometimes made somewhat harder and fluxed at the paving plant to any desired penetration.

Construction of the Pavement

In considering this phase of the subject it is assumed that the pavement of whatever exact character is laid upon a stable foundation. This is an important feature in all structures, and particularly so in an asphalt pavement, as the asphalt is simply a carpet, the foundation being the floor, which must sustain the actual load, the function of the pavement being to stand the surface wear and tear of traffic. An asphalt pavement is made up of asphaltic cement and the mineral aggregate. When the first asphalt pavement was laid it consisted of what was known as the cushion coat ½ in. thick and the wearing surface 2 ins. thick. It was not deemed practicable to obtain the necessary compression by rolling the entire thickness at one time. It was found, however, in actual construction that if the cushion coat were laid when the concrete was damp, blisters would form in this cushion coat, so that when the upper portion was placed upon it

the entire pavement would not be bonded with the foundation. It was also found that it was difficult to be sure of a perfect bond between the two layers of asphalt, so that these sometimes slipped one upon the other and sometimes slipped on the foundation. To obviate this the pavement was changed by the introduction of what was known as the binder coat, which was generally laid 1 in. thick upon the concrete. This was made up of asphaltic cement and stone free from dust ranging in size from 1 in. in diameter down to that which would be held on a 10-mesh screen. It was supposed that the coarser stone would take a better hold on the concrete, and by not having the voids filled the wearing surface would bond more closely with the binder. This was found in actual practice to be correct, but it was also discovered that where traffic was heavy the wearing surface would be pounded into the voids of the binder and so cause the surface to become uneven and thus receive undue wear. To overcome this on heavy traffic streets a close binder is generally laid, the voids between the stones being filled with a mixture approximating that of the wearing surface, producing a result that will still permit of a close union with the foundation and the wearing surface, and also provide a mixture free enough from voids to prevent any trouble caused by heavy traffic. Pavements of this character are laid sometimes with a 1-in. binder and a 2-in. wearing surface, and sometimes with a 1½-in. binder and a 1½-in. wearing surface, depending upon the ideas of the engineer.

Wearing Surface

The wearing surface proper is made up of asphaltic cement, sand and mineral dust. The sand is really the wearing part of the pavement, the function of the asphalt being simply to hold the particles of sand together and of the mineral dust to supplement the sand by partially filling its voids so that when mixed with the sand and the asphalt the mixture will be as dense as possible. This is necessary not only to obtain a surface that will best resist the action of traffic, but also to prevent the absorption of water, which would cause disintegration and decay.

The character of the asphaltic cement has already been commented on, and it is not necessary to take up here

the different machines and appliances which are in use for making the tests considered necessary. The consistency of the cement is important, as upon it depends the character of the pavement itself. While it is difficult to make a scientific determination as to what degree of hardness the cement should have, on account of the differences in sands and climatic conditions, an arbitrary rule for consistency would be to lay the pavement as soft as possible without its being deformed under traffic in warm weather. This will probably give the longest life obtainable for the pavement. As the oxidizing effects of the air begin as soon as the pavement is laid, the more volatile part evaporates and the pavement becomes hard. If the traffic is such that the pavement is not worn out, its life will be increased by the length of time that the deterioriating effects of oxidation will be held back, and the softer thé pavement the longer this effect will be prevented.

The character of the sand is important, because, as has been said before, a pavement as dense as possible is required, and this density should be made up, to as great an extent as is practicable, by the mineral aggregate, as the voids between the grains of sand must be filled with the asphaltic cement, and the smaller these individual voids are the more stable will be the pavement. There has always been more or less discussion as to the size of the sand to be used. The writer, however, believes that the coarsest grain should pass through a 10-mesh sieve, and from that be graded down to dust. Of course it is exceedingly difficult to obtain in all localities a sand ideal for asphalt pavement, although it is often approximated by mixing two different sands together. Specifications generally provide that sand shall have certain proportions, passing through sieves of different size meshes, allowing considerable variation in these percentages on account of the difficulty of always securing the desired sand. It would seem, however, that it would be better to establish a standard of what would be ideal sand and then let contractors approximate this as nearly as possible. The writer believes that the classification shown in the table following would produce a first class pavement, other conditions being satisfactory.

CLASSIFICATION OF SAND.

	Standard Heavy.	Limits.	Standard Light.	Limits.
Bitumen	11	10½-12½	10	9½-10½
Passing 200-mesh	12	10-14	10	8-12
Passing 80-mesh	26	22-30	12	10-14
Passing 40-mesh	34	30-38	38	34-42
Passing 10-mesh	17	14-20	30	26-34
Penetration 77° F.	45	40-55	65	55-75

The relative proportions of the asphaltic cement and the sand and dust to be used will depend upon both the character of the sand and the asphaltic cement and the traffic of the street, as well as climatic conditions. The refined Trindad asphalt contains approximately 55 per cent. of bitumen, Bermudez asphalt 95 per cent., and the oil asphalts generally 99.5 per cent., and the flux can be considered as being 100 per cent. bitumen. It will be seen that a cement made of these different materials will contain different amounts of bitumen, and consequently different amounts of cement must be used in order to produce a certain amount of bitumen in the pavement, and this is generally stipulated in the specifications. This amount varies from 9.5 to 12.5 per cent., according to general conditions.

In preparing the binder, if for a light traffic street, sufficient bitumen is added to thoroughly coat the stone, which should range in size from 1 in. in diameter down to such as will be held on a 10-mesh per inch sieve, and the street then rolled with a suitable roller. If a close binder is desired for a heavy traffic street, stone dust or sand should be mixed with the stone in such quantities as will fill the voids and sufficient asphaltic cement added to bind the entire mixture together. For the wearing surface the asphaltic cement, sand and stone dust are mixed in pre-determined quantities and then taken to the street and spread upon the binder, and raked out evenly to such a depth as will give the required thickness to the pavement when completed. Great care should be taken in the raking to see that no bunches remain in the mixture, so that the entire surface will be covered with a mixture uniformly dense and that the same amount of rolling will give a finished pavement that is uniform. The material should be dumped upon the binder at a temperature of about 275° F., and, after having been raked smooth, rolled with a hand roller, followed by one of five tons, and eventually with one of ten tons, the rolling to be continued until the pavement has

been thoroughly compacted. This rolling should be done with particular care, so that the crown of the street shall be kept uniform, cross rolling being employed whenever the width of the roadway will permit.

In the construction of an asphalt pavement there are two points upon which the practice does not seem to be uniform in the different cities. One is the treatment of the gutter and the other the area adjacent to street car tracks.

As regards the former, many cities lay a gutter of brick, or stone, of some foot and a half or two feet in width, as it is thought that the water, which naturally collects in the gutter unless the grade is absolutely perfect, would cause asphalt to disintegrate and be otherwise unsatisfactory. While there is no question that a stone or brick gutter is more durable than one of asphalt, it has been the practice in the Borough of Brooklyn to lay the asphalt up to the curb, except in some few cases where the streets were curbed and guttered before the pavement was laid, and from its experience it would seem that this action was justified, as in no case has the cost of repairing the pavement in the gutter exceeded the average on the street surface enough to make it necessary to lay the more permanent gutter.

The same difference in practice applies to the treatment of the area adjacent to the rails of the street car track, and here the Brooklyn practice has been the same, namely, to lay the asphalt up to the rails themselves without any intervening material. The objection urged against this practice is that the pavement next to the rails is subjected to more heavy traffic than the rest of the street, and that on account of the rails it gets out of repair more quickly. This is perhaps true if substantial track construction is not carried out. If the track itself is in such condition that there is a material amount of motion in the rails under car traffic, the above contention is undoubtedly true, but if the tracks are laid in the most approved modern way the writer does not believe that there is any necessity for, or any objection to, laying the asphalt up to the rails. If any different material intervenes, it will be difficult to make a satisfactory joint between the two materials, as this joint is parallel to traffic and in the portion of the street where the same is liable to be heavy. With a strip next the curb and another next the rails paved with stone, a comparatively small space would be left for the pavement proper.

There is also a question as to the advisability of paving the space between the tracks and the rails with asphalt. The writer believes that with the best modern street car track construction it is more beneficial to the railroad corporation and to the public to have the space between the tracks and between the rails paved with brick, wood or smooth stone blocks with close joints, than to have the same space treated with asphalt. The railroad company is interested both from an operating and a maintenance standpoint, and the public is interested to have such a pavement laid as will cause the least inconvenience in maintenance and repair. The writer believes that on a railroad street the best possible construction, where asphalt is to be used, is to lay the asphalt from the curb to the tracks and pave the remainder of the street with any of the above materials. With a modern grooved rail and proper construction, pavement can be so laid that traffic will pass across the tracks from one side to the other with no appreciable interference.

Maintenance and Repair

When the original guarantees on the first asphalt pavements began to expire the question of keeping the streets in repair was a perplexing one. As has been said, little was known about the material or how to use it, and it was necessary to have recourse to the contractors themselves to repair the pavement. As a general proposition this was wrong, as no city should be in a position in which it would be dependent in any way upon any contractor for any work. It should rather be so situated that it could make repairs in a street at any time. In order to do this the municipality must own an asphalt plant, and many of the largest cities of the country in the last few years have built and operated their own plants with the best of results. It was thought by many when this plan was first proposed that there would be difficulty in obtaining asphalt for use, but no such difficulty has occurred.

Probably the first city to have an asphalt plant was Winnipeg, in Manitoba, where it is used for the construction of new pavements as well as for making repairs. Detroit, New Orleans, Toronto, and the Borough of Brooklyn, New York City, also have municipal plants in active operation.

In the Borough of Brooklyn a municipal plant has been in use for five years, and the cost of repairing all of its

asphalt streets out of guarantee has been 3.68 cts. per sq. yd. per year.

As an indication of the effect of street car tracks upon the wear and tear of pavements, it should be noted that in 1911, in the Borough of Brooklyn, the cost on street car track streets was 6.5 cts. per sq. yd., while on streets without car tracks it was but 2.9 cts.

In the city of Buffalo, where probably a larger amount of asphalt has been kept in repair than in any other city, the cost for maintaining 43,000,000 sq. yds., scattered over a term of years, has been 3.78 cts. per sq. yd. In this city the repairing is done by contract, the contractor being paid a unit price per sq. yd. for work actually performed.

In Toronto, Canada, repairs made with the municipal plant cost 77 cts. per sq. yd. of pavement actually laid, while in Detroit, which also used a municipal plant, the work cost $1.06 per sq. yd. during the past eight years.

In this connection it should be said that the actual cost will vary in accordance with the methods used in making the repairs and also the state of repairs in which the streets are kept. This is particularly important, as what might be considered good repair in one city might not in another. In Buffalo the authorities say frankly that if all streets had been repaired as they should have been the cost would have been somewhat greater.

Life of an Asphalt Pavement

A great deal of discussion and consideration has been given by different engineers to learn what is the normal life of an asphalt pavement. This life, of course, depends entirely upon conditions, traffic and otherwise. For instance, the Engineer of Paris states that on some streets the life would be but two or three years, while on others it would be twelve or fourteen years, according to traffic. Mr. Geo. H. Norton, Deputy Engineer-Commissioner of the city of Buffalo, in a recent article in the "Engineering News," has given the most valuable information on this subject that has ever been presented to the public. In a careful analysis of the results of the work in Buffalo for many years he deduces that in that city under their conditions the average life is twenty years, and from his showing it would be difficult to dispute his conclusions. Officials of the city of Washington also estimate the life

to be twenty years under ordinary conditions. The writer, in considering this matter, so as to make a comparison with other pavements, has generally taken the life to be eighteen years. In his case, however, it is merely an arbitrary conclusion, based on his own observation and study.

In determining, however, the life of a pavement it must be remembered that asphalt being a continuous pavement and the repairs being patches, the pavement can be kept in use indefinitely if sufficient work is done upon it each year. There comes a time, however, when this patching becomes so great as to be extravagant. The items which go to make up the cost of the pavement are interest on the money invested, the cost of repairs, and the amount deposited to create a sinking fund that would repay the original cost. That is, if a city should borrow money to pave a street, its annual expense would be the interest on the bonds, the cost of repairs and the sinking fund, and when the cost of repairs exceeds what these three items would amount to for an estimated life of the pavement, the pavement should be relaid. In determining the above amount the cost of repairs would be the estimated average amount per year for the entire life of the pavement. The bonds issued should be for a term equal to the expected life of the pavement. In this way a fund would be provided for the perpetual maintenance of the pavement. If, however, the pavement is paid for by assessment when the same is laid, of course there would be no interest or sinking fund, but the principle to be applied would be the same.

In studying this subject during the past season the writer obtained from the cities of Buffalo, Rochester, Washington and the Borough of Brooklyn, New York City, the cost of keeping their different pavements in repair for the successive years out of guarantee, the rule being applied to those pavements where the guarantee had been for five years. The costs in the city of Washington have been applied to streets that have been laid thirty-three years. For the first year out of guarantee the pavement cost 2 cts., for the second year about the same, running up to a little over 4 cts. the third year, gradually increasing to a little over 5 cts. in the eighth, then decreasing to 4 cts. in the eleventh, and running in a fairly uniform line to the nineteenth, when they reached 6 cts., and then gradually reducing to

2 cts. in the twenty-eighth year. These figures refer to a large number of streets, except in the streets that have been out of guarantee more than twenty-three years. The strange thing is that the cost has been not more than 6 cts. for any one year, and after the nineteenth year becomes less.

The records in Rochester have been kept for pavements twenty-seven years old, in Buffalo twenty-five years old, and in the Borough of Brooklyn fifteen years old. These costs on the whole are about the same and fairly consistent with themselves, the Rochester costs being slightly less and Brooklyn slightly more than those for Buffalo.

No matter what the kind or the character of materials used it is necessary that they be handled with intelligence and a thorough knowledge of their different characteristics. It is undoubtedly true that inferior materials properly used will make a better pavement than good materials in the hands of ignorant workmen. Asphalt pavement is an artificial product, and, like all of its kind, can never be amsolutely uniform. In the early days, when these pavements were laid more by guess work than by knowledge, when a pavement was found to be particularly good the contractors would make a complete chemical and mechanical analysis of same and then reproduce it as exactly as posible on other streets, but the results would not be the same. This seems strange, but is undoubtedly due to the elusive qualities of asphalt.

In Omaha the first asphalt pavement was laid on Douglas Street in 1883. This was the first asphalt pavement laid west of the Missouri River. The sand in the vicinity of Omaha is well known to be poorly adapted for use in asphalt mixtures. This street was in the downtown section of the city, where it had more than normal traffic, yet it remained in use twenty-five years before it was repaved. It is doubtful if many of the modern asphalt streets will be able to show as good a record.

Asphalt Block Pavements

Another kind of asphalt pavement is what is known as the block pavement. This has the one great advantage of being prepared at the plant by intelligent and experienced workmen and then shipped to the street in a proper condition for use. This kind of pavement has been in vogue

for some thirty years. For many years after it was first laid the blocks were manufactured practically by one company, who did their utmost to make a good block, so that definite specifications for the blocks were not used by engineers and were hardly necessary. As time progressed, however, the manufacture of blocks was taken up by other parties, when it was found absolutely necessary to have positive and definite specifications. When asphalt blocks were first used they were made 4 ins. wide, 5 ins. deep and 12 ins. long, but the thickness has been gradually reduced until at the present time the usual thickness is 3 ins., and in some instances 2 ins. for light traffic streets. The specifications which are now in use in the Borough of Brooklyn, New York City, and which are probably as definite as any in the country, provide that the stone shall be trap rock as nearly cubical as possible, of a size to pass a ¼-in. sieve, not less than 40 per cent. to be retained on a 20-mesh sieve and not less than 12 per cent. to pass a 100-mesh sieve. If the stone as received does not have this amount of fine material, dust is added to make the desired quantity, and in any case not less than 6 per cent. of dust shall be added. The blocks shall contain not less than 5¾ nor more than 8 per cent. of bitumen; the specific gravity of the blocks to be not less than 2.5. It is further provided that after being dried for twenty-four hours at a temperature of 150° F., the blocks shall not absorb more than 1 per cent. of water when immersed for seven days.

The failure of many blocks made by inexperienced contractors, where good materials are used, is due generally to the blocks not being sufficiently dense. A dense block must be made in order that it may have a specific gravity of 2.5. This will be apreciated when it is known that the specific gravity of ordinary sheet asphalt is aproximately 2.

The stone in the asphalt block being so much larger than the sand in sheet asphalt, it is less slippery and can be used upon grades where it would not be desirable to use the sheet.

Another advantage is that, having the technical work done at the plant, the material can be used on the street, both in the original construction and for repairs, without any elaborate machinery, so that the work can be done with less difficulty than where a plant is required. A partial

offset to this, however, is the expense of freight in shipping from the plant to any city that is a material distance from the work.

The blocks are laid on concrete, as is the sheet asphalt, but firmly bedded in an intervening cushion of mortar formed of 1 part Portland cement and 2 parts sand, the mortar being mixed as dry as will permit of its setting. The joints are filled with sand, and, after the pavement has been used for a short time, become practically waterproof. Experiments have been made to test the quality of the blocks before laying in much the same manner as vitrified brick are tested, but the practice has not yet come into general use by cities.

Bitulithic Pavement

In this pavement the binding material is either asphalt or coal tar. The pavement is patented and it was originally intended to use coal tar, but asphalt has since been substituted to a greater or less extent. When the pavement was evolved the idea was to construct an improved macadam pavement, the bitumen acting as the binding material, but the results of the experiments seem to show the possibility of a more permanent pavement, and its present form was evolved after much labor and research work. The principal idea is that the voids in the stone shall be as small as possible, the materials being pre-determined and apportioned by weight by elaborate machinery, so that there will be produced, in the languauge of the contrator:

"A mixture which, when combined with the bitulithic cement and compacted together will form a bituminous street pavement structure containing mixed mineral ingredients of such grades as to give the structure inherent stability and one in which the largest and smallest pieces are associated with each other indiscriminately throughout the structure and in which the plastic bituminous composition permeates the entire mass, uniting the various sized particles thereof, filling the voids, and forming the wearing surface."

The maximum size of stone used is approximately 1 in. in diameter, and on this acount the pavement can be laid on steeper grades than the sheet asphalt. The first pavement of this character was laid in Pawtucket, R. I., on a 7½ per cent. grade, and the engineer of that city says

that no trouble whatever has been caused by slipperiness. Up to February, 1912, about twenty million square yards of this pavement had been laid in this country.

The writer has had no personal experience with this form of pavement, but has seen many pieces, some which had been laid eight or nine years and which were said to have had practially no repairs during that time, and the appearance of the pavements would seem to indicate that this was so.

The writer feels that bituminous pavements have obtained deserved popularity in this country, and while possibly the durability of these pavements is not equal to that of the asphalt pavements of Europe (which are of entirely different charater), still for retail business and residence streets they are extremly desirable and satisfactory pavements.

CHAIRMAN PARKER: I should like to have you feel that it is a privilege and a great advantage to everyone of us who is interested in this matter, to have a paper of this sort read before us and put upon our records. We have fifteen minutes in which to discuss Mr. Tillson's paper, and any of you gentlemen who have anything to say will be welcome to say it, or if you want to ask any questions I have no doubt that Mr. Tillson will be glad to answer them. Now, if anybody in the audience wants to say anything, we will be very glad to recognize him. Mr. Richardson, won't you say a word?

CLIFFORD RICHARDSON (Consulting Engineer, New York City): I merely say in confirmation of the chairman's remarks that Mr. Tillson's experience with street pavements, as you probably know, has been long and broad and large. We can listen to him with great confidence in anything he has to say. I have heard his paper with great interest and can commend it to you all. I have little or no comment to make upon any of the conclusions which he has addressed to this assembly.

CHAIRMAN PARKER: I hope you won't hesitate, gentlemen, to say anything you have in your mind, or ask any questions. Mr. Compton, haven't you something to offer to us?

R. KEITH COMPTON (Chairman, Paving Commission of the City of Baltimore, Baltimore, Md.): Mr. Chairman

and Gentlemen:—I realize that I have been listening to one of the most distinguished engineers in this country. I really came to Cincinnati to hear Mr. Tillson, and see Mr. Parker.

Now, I was so much interested in Mr. Tillson's address, that I made a few notes before I came in here, hoping that he would take up those very points, and he has covered most of them. I was in hopes that he would deal with inspection, but it seems that he did not. We are very much interested in that in Baltimore. As you know, Baltimore is expending $10,000,000 on her paving. We are completely reconstructing the city along that line. Now, first as to our system of inspection: We have six asphalt plants operating in the city. They are out on the boundary lines of the city, and they cover every point of vantage. Our system of inspection is this: We have our own laboratory, and we have a plant inspector and a general inspector. The general inspector takes my machine at 7 o'clock in the morning, and he visits each plant, and his sub-inspectors are provided at the plants with certain implements to make the usual tests, viscosity, penetration, and sieves for machine composition. The general inspector looks over those fellows, and takes samples from the plant, and then at various times during the day visits the work, takes samples from the work, and goes to his laboratory and checks one against the other; and we think that we have a very broad and general scheme for inspection.

Now, we have been getting most excellent results with bituminous concrete. Just before the convention, we wanted a smooth street leading from Union Station over to Mt. Royal Station. The street had not been released by the Sewage Commission, so we had not put down what we thought was a permanent pavement. So we placed some bituminous concrete right down over the cobblestones. Notwithstanding the fact that that street is subjected to intensely heavy traffic—coal carts going into the freight yards—that pavement is standing up wonderfully well.

I would like to say something about the base. A great many of our friends in Baltimore thought that we could resurface every cobblestone street in the city, using the cobblestone as the base. Well, we didn't want to do it, but

we gave way to public pressure and tried some. We found where the cobblestone had been disturbed, digging trenches or things of that sort, that it was utterly impossible to get the cobblestone back in as safe a condition as it was when it had been pounded down by traffic for generations. So we had to put concrete over the trenches, and by the time we fooled around putting concrete over the trenches and so forth, we found that we had expended within 5 cts. as much as if we had torn up the whole business and put in a concrete base. So we have given up that idea. On the heavy traffic construction we put in a 6-in. base. On the light traffic construction, assuming that the ground is good, we put in a 4-in. base.

Now, as to gutters: Our experience along that line is not just exactly in accord with Mr. Tillson's. We find that brick gutters are absolutely necessary. I know of one instance where asphalt has gone to pieces against the curb in three months, and I know of another instance where it has gone to pieces inside of a year.

Now, track construction: Our tracks are not laid on concrete. They are on stone ballast. We get a fairly good construction. We find that we can't put sheet asphalt against the tracks. We usually use hard material, either granite block or vitrified block, and in some instances wooden block. We get excellent results with wood block along the rails instead of running sheet asphalt up to the rails. We find the wood block takes up the vibration of the track. It has a certain amount of resiliency and gives most excellent results.

Now, asphalt blocks: Asphalt blocks were first laid in Baltimore 30 years ago, as Mr. Tillson states. Some of those blocks, notwithstanding the fact that they are on a sand base, are in place today and very good still. We are now using trap blocks. That is all I have to say.

CHAIRMAN PARKER: We have a few more minutes and I am going to ask Mr. Rourke of Boston to say a few words.

L. K. ROURKE (Commissioner of Public Works, Boston, Mass.): Mr. Chairman and Gentlemen:—I realize who Mr. Tillson is and it would certainly be presumptuous on my part to attempt to discuss his paper. It seems to me to be almost the last word on bituminous pavements. I might say a few words, however, about our conditions

in Boston. We haven't found asphalt much of a success, due to our geographical condition. We have very narrow streets, in the first place, and secondly a great concentration of traffic—too much traffic for asphalt except in residential streets. I was interested in the figures which he gave on repairs made by municipal plants. I would be further interested to know how these figures are gotten at, whether those men engaged in asphalt repairs were kept on the payroll when they were not engaged in repairing asphalt, and how much of the overhead charges were charged to that. We have in our city only about 350,000 sq. yds. of asphalt. Every year we call for a contract for repairs. We get figures down to about $1.20 per yd. We have never been able by any municipal plant or municipal work to reach that figure. Now, we are up against another thing in Boston; I don't know whether we are asking too much for our money or not, but the last street advertised for asphalt was a short residence street—the only streets where we attempt to use it at all any more—and we received one bid. In other words the asphalt contractors have left Boston. If any of you are engaged in that business, I would like to have you come down and talk it over with me and perhaps we can start it up again. (Laughter.)

MR. TILLSON: Mr. Chairman, I would like to answer Mr. Rourke's question because the operation of the municipal plant in Brooklyn is something that we all are very proud of there, and particularly so because I advocated it for a long time before I could get it, and when I did advocate it we had a man in the finance department who said that if we established this asphalt plant it would be impossible for us to purchase the asphalt because the people owning the asphalt would combine and prevent the city from buying it. In answering specifically Mr. Rourke's question, the figures on repairs in Brooklyn are figured exactly as they would be by a contractor. That is we have a plant which has cost us so much money. We have to keep in repair between four and five million yards of asphalt per year. We have a superintendent of repairs who has an automobile and who receives $3,000 a year. Now his time, the cost of the automobile, the cost of the chauffeur, the cost of all the men at the plant, the interest on the plant, the depreciation of the plant, and the loss to the

city on account of no taxes being paid for it, are all figured in. In fact, every overhead charge is figured in arriving at this cost per yard; and this cost now you will understand, was an average over the entire area. If we have 5,000,000 yards that are being repaired, and the total cost of repairs is $50,000, $50,000 is divided by 5,000,000 to get the cost per square yard per year. That has been the absolute cost, figuring in every item of cost that would be put in overhead charges and all.

MAJ. CROSBY: It isn't the cost of the actual repairs made, but it is the cost over the whole yardage?

MR. TILLSON: Yes, not the cost per yard of actual yardage laid. For instance, if we had 1,000 yards, and it cost $35, it would be 3½ cts. per yd. The contractor is generally paid so much per yard for what he actually lays.

MR. ROURKE: May I ask Mr. Tillson one question? What does this force of men do during the year, the men who are engaged in this work, when they are not engaged in patching?

MR. TILLSON: There is enough patch work to keep them busy, including the repairs to the cuts that are made by the contractors and the subsurface people. When they are out of work they are laid off.

MR. ROURKE: We couldn't lay them off in Boston; that is the point I wanted to bring out.

CHAIRMAN PARKER: I think this discussion has produced some very good points. At any rate, it has brought out the combative spirit of the New Englander which you observe in Mr. Rourke. He wants to know what the bottom facts are.

This telegram has just been received. I will read it to you, gentlemen, because it seems to be of interest.

Jacksonville, Fla., Dec. 3, 1912.

American Road Builders' Association, in Session, Cincinnati, O.:

The State Good Roads Association of Florida, through its officers and Board of Governors, sends greetings from the "Sunny South" to its brethren in convention in the "Chilly North." Best wishes for a successful convention. Work well organized here; much road building. Hope to secure State Highway legislation next spring.

(Signed) DR. W. N. STINSON, President.
A. B. DUNNING, Secretary.

The next in order, gentlemen, is a paper on "Creosoted Wood Block Pavement in the City of Minneapolis, Minn.,

as Laid by the City by Day Labor." This paper has been prepared by Ellis R. Dutton, Assistant City Engineer of Minneapolis.

(Mr. Dutton not being present, his paper was read by Chairman Parker.)

CREOSOTED WOOD BLOCK PAVEMENT IN THE CITY OF MINNEAPOLIS, MINN., AS LAID BY THE CITY, BY DAY LABOR

By ELLIS R. DUTTON

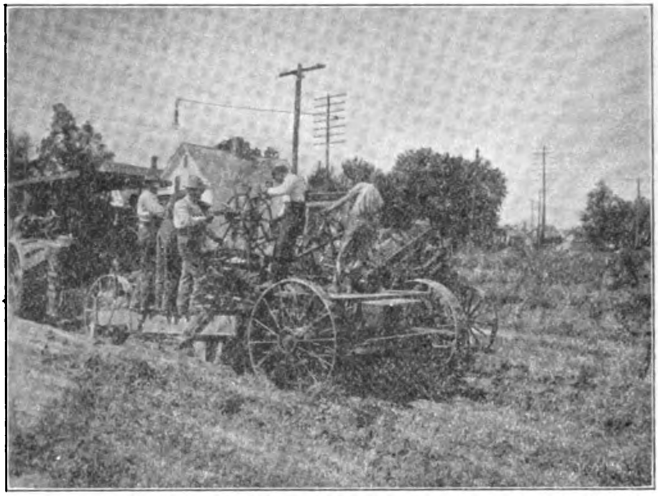
Assistant City Engineer, Minneapolis, Minn.

The city of Minneapolis has at the present time over 1,000,000 square yards of creosoted wood block pavement, laid by day labor.

In 1901, the city officials began investigating to find a paving material that would be better than that they had been using. The sheet asphalt was unsatisfactory, being put in by the asphalt company under a guarantee which they did not live up to but allowed holes to remain in the paving for a whole season. The brick paving was too noisy and the sandstone blocks wore badly. The merits of a creosoted wood paving having been put forward by parties interested, the paving in Indianapolis and the blocks in front of the Auditorium in Chicago were investigated, and it seemed that in this they had found the best paving for this city. Accordingly, in 1902, the City Council ordered 10th Street South, from 1st Avenue South to Park Avenue, to be paved with creosoted wood blocks similar to those used on Michigan Boulevard in Chicago. Quite a few people opposed this kind of wood pavement, remembering the experience we had had with the old cedar blocks which had been used so extensively and not knowing the difference between them and the ones proposed. Notwithstanding the opposition, the street was paved in 1902, the city purchasing the blocks from the Republic Creosoting Company of Indianapolis.

The blocks were 4-in. southern yellow pine, treated with 12 lbs. of "Kreodone" oil, which was a trade name for a better quality of creosote oil.

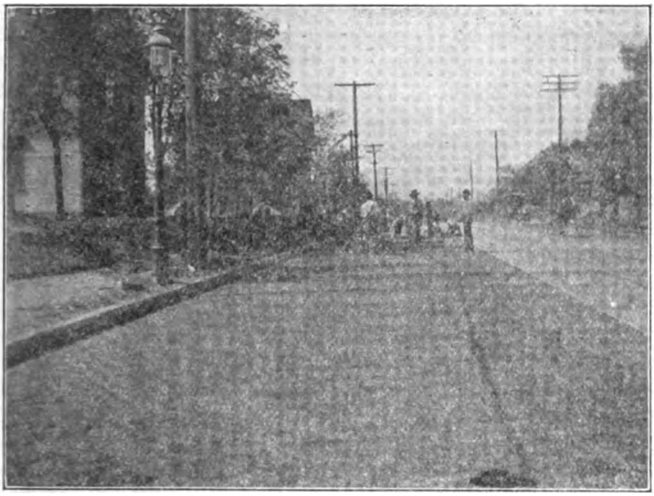
There were laid 13,500 sq. yds. and the cost for pavement, complete, was $2.79 per sq. yd., the city of Minneapolis doing all the work by day labor and purchasing the



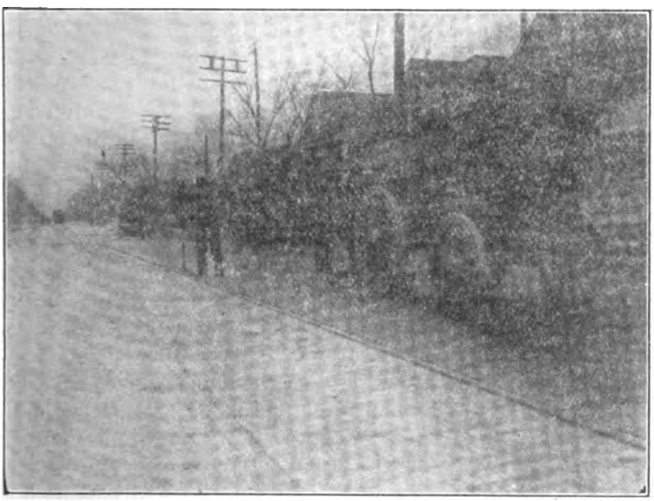
Preparing the Subgrade.

Laying Concrete Foundation.

LAYING WOOD BLOCK PAVEMENT IN MINNEAPOLIS, MINN.



Laying the Wood Blocks.



Filling the Joints.

WORK DONE BY THE CITY BY THE DAY LABOR PLAN.

blocks at $1.95 per sq. yd., f.o.b. Minneapolis. These blocks were laid upon a 6-in. natural cement concrete foundation, over which was spread a 1-in. cushion of sand, upon which the blocks were laid at an angle with the curb of about 62 degrees. There were no cross expansion joints used, only a 1-in. joint on each side of the street next to and parallel with the curb. These joints as well as the joints between the blocks were filled with paving pitch, and the street was finished with a ¼-in. coating of sand to absorb the excess pitch on top of the blocks. In laying these blocks, we considered that it would be better to lay them at an angle with the curb instead of at right angles, both on account of the travel and also the expansion, and the correctness of the assumption has been proven by experience.

In the experimental blocks which were laid on Nicollet Avenue, by the Forest Service, the creosoting company and the city of Minneapolis, observations made in 1912 prove that it is better to lay the blocks at an angle of approximately 62 degrees, as that method shows less wear of the joints than any other. The pavement on 10th Street has proved a complete success, as there have been practically no repairs on account of the blocks, and the wear has been only about ⅛-in. up to the present time.

This pavement looked so good and seemed to be so satisfactory, that in 1903 it was determined to lay more of this class of paving. Minneapolis being situated in a pine country and being one of the largest centers of pine lumber manufacture, it was asked "Why not use our native Norway pine for the work?" The matter was discussed and finally it was decided to use Norway pine, treated the same as the yellow pine. Accordingly, arrangements were made for the erection of a treating plant in Minneapolis, if the city would use 30,000 sq. yds. of creosoted Norway pine blocks. The price of this class of blocks was $1.64 per sq. yd., f.o.b. Minneapolis, using 12 lbs. of "Kreodone" oil per cu. ft.

In the paving of 3d Avenue South in 1903, there were left over from 1902 about 300 yards of the yellow pine blocks which were used in this street, and the remainder was Norway pine. In 1911, I took out some samples of these two classes of wood, which had received exactly the same travel and wear, and found that the yellow pine blocks showed a wear of ⅛ in. and the Norway pine blocks twice

as much—¼ in. This was an actual comparative test of the two kinds of wood on the same street and under the same conditions.

In 1904 the price for blocks was $1.73 per sq. yd., f.o.b. Minneapolis, but there were proposals as low as $1.51 per sq. yd., using common commercial creosote oil. The engineers and the paving committee considered the higher priced blocks, treated with the best grade of oil, to be the better and cheaper. It was believed that the oil that contained the larger percentage of residue after distillation to 315° C. was the better. The cheaper oil showed 43 per cent. of residue and the best showed 70 per cent. of residue. The latter was used and there was much criticism made and much newspaper notoriety given the matter, but the wisdom of the purchase has been shown by experience.

One piece of work that was done in another city using the cheaper oil never was satisfactory, and was replaced some time ago with a better grade of paving blocks. These proposals were made under a specification requiring the bidder to submit samples of oil and blocks, and the difficulties arising therefrom led me to draw new specifications defining the exact kind of oil to be used. It required a very great amount of study and a great number of experiments to determine just what kind of oil would be required, and to specify an oil that would be commercially practicable. You might specify an oil which could not be made in large quantities at anywhere near a reasonable price. There had been no specifications of the kind made previously for paving blocks, and there was no printed matter or books that could be consulted, so the matter had to be tried out.

The specifications of 1905 required an oil of a gravity of 1.09 at 20° C., and specified the fractional distillation percentages. These were the first specifications of the kind and they have been followed throughout the country ever since. The idea of specifying what is required should be adopted for all classes of paving and paving materials, as it places the contractors on an equal footing, and the municipality gets what it asks for, provided the engineers know how to get it. And this brings up the question of inspection, and there is no class of paving that requires more rigid inspection than the creosoted blocks, and if it is possible

to obtain a competent person to do the inspecting it is money well spent. We also raised the amount of oil per cubic foot to 16 lbs. this year, as it was considered better to fill the wood more thoroughly and make the blocks more waterproof. This amount has not been changed since, though other cities have put in 20 or more pounds, which, I think, has caused other trouble. The price of the blocks was $1.49 per sq. yd. f. o. b. Minneapolis, for 4-in. Norway pine.

We continued the use of Norway pine, tamarac and hemlock until 1911, when we returned to the yellow pine blocks which seemed to give the best results, especially on heavily traveled streets. We also used a 3½-in. block on the lighter traffic streets. We have had no trouble with our creosoted block pavements, though on one particularly heavily traveled street the Norway pine blocks have worn about 2 ins., and will soon have to be relaid.

On Jan. 1, 1912, we had a total of 968,000 sq. yds. of creosoted wood block paving, put in at a cost of $2,466,-000, or an average of $2.52 per sq. yd. The prices have varied, as the prices of material varied, from $2.29 per sq. yd. in 1908 to $2.82 per sq. yd in 1907. The price of the crushed limestone used in the concrete base averages about $1.75 per cu. yd. delivered on the street. The sand costs about 75 cts. per cu. yd., and Portland cement has cost from 86½ cts. to $1.80 per bbl. delivered f.o.b. Minneapolis, depending on the year. The cost of paving as given above includes the grading for the foundation, the laying of the concrete base, the paving blocks, pitch, and all the labor connected with making a complete pavement. I have not heard of a city that gets as much for the money as we do. The city of Minneapolis does all of its public work by day labor and has done so for the past twelve years, with the exception of asphalt paving, which it could not do as it had no asphalt plant. The wages paid common labor in paving work have increased from $1.75 per day of 10 hours to $2.40 per day of 8 hours in 1912. The costs of skilled labor and teams have increased almost as much in proportion.

We have tried to eliminate the question of politics from the work, and have been partly successful, but the political question is the weak point in the day labor system. All work is done under the direction of the City Engineer, but

is ordered by the City Council through the various committees, such as Water Works, Sewer, Paving, etc. All materials are advertised for and contracts awarded by the City Council. I think that as a general thing we get better work and better materials under this system than in much of the work done by the contract system. There is no disposition or reason to slight the work in any way under the day labor system if done under proper safeguards. The political tendency might be to do as much work by hand labor as possible, but we have gotten away from that and are using labor saving machinery wherever it is deemed more economical and whenever the money is provided to purchase such machinery.

To show the preference for the different kinds of paving, from 1902 to 1912, the following table is given:

CHARACTER OF PAVEMENT, JAN. 1, 1902, AND JAN. 1, 1912.

	Square Yards		
Kind of Pavement.	Jan. 1, 1902.	Jan. 1, 1912.	Increase.
Sheet asphalt	206,471	164,441	42,030*
Brick	171,144	390,869	219,725
Creosote blocks	....	967,616	967,616
Granite blocks	156,994	403,915	246,921
Sandstone blocks	61,661	347,939	286,278
Macadam	129,305	335,159	205,854

*Decrease.

Omitting the sheet asphalt, this shows that in the last ten years the area of all kinds of pavement other than creosoted wood blocks, has increased 958,778 sq. yds., and that during this time there have been constructed 967,616 sq. yds. of creosoted block pavement, a little more than all others combined. I give this to show what kind of paving the people prefer, for it is the people that ask for it and pay for it. I have omitted from the table the old cedar block pavement which was laid quite extensively some years ago and which has been almost entirely replaced. I think the people's preference has been largely on account of the success we have had, as we have had no "buckling," "bleeding" or other difficulties which have been experienced in other places.

The Minneapolis creosoted wood block pavements have been used as a sample, and a great many delegations from other cities have inspected our paving in attempts to determine what was best for them to use. There have been a great many contractors and engineers looking at our work

and trying to find out how to do it and to learn the reason for our success in this class of paving, and I suppose they all did.

There are several things necessary to properly construct a creosoted wood block pavement:

1—The proper kind and quality of wood.

2—The proper kind and quality of oil.

3—The proper amount of oil and treatment.

4—The blocks must be laid properly.

5—The joints must be filled properly.

6—The pavement must be cared for properly after construction.

I have touched on almost all of the points, and if they are looked after properly in a careful manner by competent persons, you will get the best pavement it is possible to obtain at the present time.

CHAIRMAN PARKER: Before beginning the discussion of this paper, Mr. Lewis, the President, has asked me to read to you the followng telegram, which he has just sent:

To Hon. J. P. Harlan, Good Roads Convention, Tacoma, Wash.:
American Road Builders in ninth annual session assembled, send, through their officers, cordial greetings to Washington convention.

(Signed) NELSON P. LEWIS, President.
E. L. POWERS, Secretary.

DR. GEO. F. HERMANN (Cincinnati, O.): Mr. Chairman, he mentions ⅛-in. as the amount of wear of creosoted block. What length of time was that?

CHAIRMAN PARKER: The time as stated in the paper was 8 years, from 1903 to 1911. Is there any gentleman here that provides wood block for contractors, or anybody interested? I know contractors are modest men as a rule.

Are there any contractors in this room? I should like to know, if you have not got anything to say about wood block—how the contractors like the idea of day labor in the different cities throughout this country. (Laughter.)

J. C. TRAVILLA (Street Commissioner, St. Louis, Mo.): Mr. Chairman and Gentlemen:—I am not a contractor but have had considerable to do with the contract-

ors in constructing all classes of pavements and have taken a special interest in the construction and maintenance of wood block pavements.

It may be of interest to some of the engineers present today to speak of the method of eliminating expansion troubles that I have inaugurated in St. Louis.

Most of the expansion troubles in wood block pavements are due to the blocks drying out in transit or on account of unusual delay in having them laid promptly in the streets during the hot summer months. To overcome this trouble, we experimented during the past summer with the use of clay as a preliminary expansion material. The method was as follows:

Instead of providing for the standard 1-in. bituminous expansion joint along the curb, a width of 1½ to 2 ins. was allowed at each curb, depending upon the width of the roadway. These expansion joints were filled with clay, the blocks rolled, wetted down and then covered with sand and the sand kept moist for a period of four days. It was found by this treatment that the clay expansion joint closed up in some instances as much as ¾ in. and that the joints between the blocks became tight. After the swelling had been all taken up, the sand was allowed to dry out and was then broomed into the joints. Later on the clay was removed from the joints and asphaltic cement substituted. However, I am satisfied that the clay in itself would have been sufficient, but since the specifications called for a bituminous expansion joint, it was necessary to use same to make the tax bills valid. I believe this is an innovation in the laying of wood block pavements, and do not hesitate to recommend its use.

Climatic conditions play an important part in the success of laying wood blocks. By close observation it will be noted that the sap of the wood holds the moisture, and this is one source of expansion trouble.

Any questions relative to this work or the construction of wood block pavements that the members desire to ask will be cheerfully answered.

DELEGATE: What block do you use?

MR. TRAVILLA: We are using the long leaf yellow pine block, treated with 16 lbs. of preservative. The blocks are 3½ ins. in depth, 3 to 4 ins. in width, 6 to 8 ins. in

length. Formerly a 4-in. block was recommended. However, we are now using a 3½-in. block and are doing some experimental work with a 3-in. block. Blocks are laid at an angle of 62½ degrees. I prefer to lay blocks at an angle to the curb. The city is buying blocks for $1.60 f.o.b. St. Louis. The contract price for wood block paving on a concrete base 6 ins. in depth, 1 in. sand base and a sand filler, with bituminous expansion joints, ordinarily runs about $2.55 per sq. yd.

DELEGATE: A sand filler altogether?

MR. TRAVILLA: Yes.

DELEGATE: I would like to ask whether you have the absorption test?

MR. TRAVILLA: No.

MR. ROURKE: What is the maximum grade?

MR. TRAVILLA: I do not recommend that wood blocks be laid on a grade exceeding 3½ per cent.

MR. ROURKE: Any trouble from slipping?

MR. TRAVILLA: In the fall of each year we oil and sand most of our wood block pavements, using about ⅛ gal. of heavy residuum oil per sq. yd., applied at a temperature of about 250° F., then covering the oil with a sharp grit. This treatment ordinarily lasts through the winter and there is no difficulty from slipperiness.

DELEGATE: Do you prefer heavy or light oil?

MR. TRAVILLA: I recommend oil varying from 1.08 to 1.10, giving preference to the lighter oil. My experience has been that there is less objection from bleeding with the light oil than from the heavy oil with an admixture of tar. (Applause.)

CHAIRMAN PARKER: Now, gentlemen, if you have all the questions asked on this matter, we will proceed to the next, which is, "Cuts in Newly Paved Streets," a paper prepared by H. M. Waite, City Engineer of Cincinnati, to be read by Mr. Barlow, Assistant City Engineer.

MR. BARLOW: Mr. Chairman and Gentlemen:—Mr. Waite was called out of the city unexpectedly, and this paper was gotten up hurriedly in his absence. It will not be his paper, but one which I prepared for him, so I don't want to put the responsibility of the paper on him.

CUTS IN NEWLY PAVED STREETS

By JAMES E. BARLOW

Assistant City Engineer, Cincinnati, Ohio

This association, I judge, has dealt principally with the construction of good roads as the connecting links between communities. An added problem arises when we come to construction and maintenance of urban roads or streets as the traffic, if we may call it such, below the surface of the roadway becomes of almost equal importance to that above. A cross section of a downtown city street will show car tracks, electric ducts, telephone conduits, water mains, gas mains, sewers, etc., and, of course, leading from these to the different buildings, would be the necessary service branches. These all constitute a network which honeycombs our pavement foundations, and it is the repair, renewal and extension of these which give rise to the problem on which it is desired to start a discussion; namely, "openings in street pavements."

It is a matter of common observation to you all that an opening repaired is never as good as the original undisturbed pavement. In addition to the general disturbance of the subsoil there is usually left a slight hummock or a slight depression in the pavement which the pounding of traffic accentuates, causing a more or less endless chain of repairs. Eminent authorities have estimated that in some cities the useful life of the pavement is decreased 25 per cent. by these cuts. The reduction in the life of the pavement in a city such as Cincinnati is probably not as great as this, but nevertheless, the damage is very real. Some idea of this damage in dollars and cents may be had when one realizes that the cost of pavements, including maintenance, interest and renewals in a modern city like Cincinnati, exceeds $2,000,000 per year, i. e., if our pavements were laid and maintained by a public service corporation, a fair annual rental would exceed the figure mentioned. Now, aside from shortening the life of the pavement, these openings cause danger and annoyance to traffic, wear and tear to vehicles; they render cleaning more difficult, they are unsightly in themselves until repaired and they are costly to restore and they later become the source of additional repairs. Thus the importance of

properly controlling such openings and reducing them to a minimum is readily seen.

As a complete solution of this problem some have suggested subways or pipe galleries under the streets with laterals to property lines. Others have suggested subways under the sidewalks, necessitating double lines of mains. However, the investments tied up in the present form of underground construction, the enormous expense necessary for subways and the fact that much of the sidewalk space where subways are most needed is used privately for buildings as areaways, all tend to throw this solution, for most cities, into the somewhat distant future. The problem thus becomes one of best controlling the present cuts and reducing the number to a minimum.

Probably the best way to bring this subject to a focus would be to outline briefly the manner in which this problem of cuts and their restoration is handled in this city.

When a street is to be improved notices of the two final steps in the legislation are sent to all the public service corporations, and again when bids are received, and again when the contractor is ordered to begin work. The object of these notices, of course, is to keep the companies informed of the status of the proposed improvement and allow them ample time to plan repairs, renewals or extensions. At the outset, however, it may as well be admitted that the franchises of these local public service corporations are such that we have little or no control over what they shall do along these lines.

As an additional lever, early this year a city ordinance was passed which virtually prevents any opening in a newly laid pavement for a period of three years, except in regular emergencies. Notices calling attention to this ordinance are sent to all public service corporations and to property holders about three months before the actual work of construction begins.

The topography of Cincinnati is such that often the heavy cuts and fills practically prohibit the laying of mains until the street is graded. On all contracts now let, if the street does not already contain water and sewer mains, they are included in the street improvement contract. We only wish we might include gas in the same way.

To prevent, in so far as possible, openings for house connections, we are now serving notices on all property owners along a proposed improvement to make water and sewer connections to their lots, whether occupied or vacant. If these are not made in 20 days, the city makes such connections to the curb line and assesses the cost thereof against the individual property. This calls forth considerable objection, but it must be borne in mind that half the owners gladly make all connections and it is only just, that we should take such steps to prevent the other half from damaging the pavement.

The preceding may all be classed as preventive measures. There is also to be considered the proper control and restoration of the *necessary* openings.

An important step in an intelligent control of street openings is to know *what* you have under the pavements and *where* these structures are. This primary information is not always in the hands of cities. In connection with an investigation for a comprehensive sewer layout, a complete underground survey is being made to locate all of the subsurface structures. These plots will be made on a scale of 40 and 50 ft. to the inch. There will be possibly 1,000 sheets, 24 by 34 ins., in the complete set. When compiled these will be kept up-to-date as a basis for our underground records and we can then more intelligently direct future underground construction.

There is, of course, also to be considered the actual making of the restorations. Several years ago a city ordinance was passed making it unlawful for any person other than the Street Repair Department to open any pavement without a permit therefor. This ordinance further provided that the application for this permit should state the location and size of the opening and the kind of pavement. Before the permit is issued a deposit is required, based on the published sliding scale of prices for the restoration of diffierent sized openings in the various kinds of pavements. No persons other than the employees of the Street Repair Department are allowed to permanently restore these openings.

The party making the opening does the backfilling and makes a temporary restoration of the pavement; if the backfilling is not properly done the Street Repair Department does it over and bills it to the party responsible.

The Street Repair Department handles the issuing of all permits and, of course, makes all rules in accordance with which such openings can be made. The control of the openings and the responsibility for their speedy and adequate restoration is thus centralized.

This outlines the principal steps taken here to control street openings. Some of these measures cause much friction and delay, especially those involving serving of legal notices which require definite periods of time before action can be taken. However, we feel that the end justifies the means.

CHAIRMAN PARKER: The discussion of this matter will be opened by a gentleman that I judge from the applause you gave him last night will be very welcome to you, and that is M. de Pulligny, of France, who is prepared to give you information on this and other matters.

M. DE PULLIGNY: Gentlemen, it is very late and you have still some work to do, so I will be very short. Moreover, the paper you have heard is so excellent and covers the subject so completely that very little is left for discussion. I may say also that the Cincinnati system for those cuts appears to be very good and similar in its principles to the system which is followed in the large French cities. So, I expect that the system being adopted both in France and in Cincinnati, no greater model can be referred to you. (Laughter and applause.)

I will only insist a moment on a suggestion which the gentleman has mentioned in his paper, but to which I do not think he has given sufficient emphasis.

In new cities, as you Americans build them at times, very quickly, or even in new streets of old cities, it seems that the problem of cuts in the pavements could be better handled if the gas and water mains (and all conduits in general) were laid under one of the sidewalks instead of occupying the roadway.

Putting other mains under the second sidewalk would involve an exaggerated expense. Such should not be the case if the company setting the first main would simply put, at the same time, a branch pipe across the street at each crossing between two blocks so as to reach the next sidewalk.

When connection with the houses in the block would be required the branch pipe should be extended by degrees through a small feeder at right angles with it, one-half of it under each of the adjoining blocks.

The branch pipe and the feeders could be of small diameter as each of the latter would be intended for feeding the houses of one-half block only and the former would require a double supply; so that the expense for laying these branch pipes and feeders should be moderate.

At the end and when all the houses should be connected, if consideration be taken of the lengths of pipes, trenches, cuts in the pavement and repairs, I believe that economy for the companies would appear in the proposed system compared with the old one.

So, I think that such a system could be and should be considered with interest by the American engineers in the new cities and in the new streets. I do not speak of the old ones.

This being said, I do not see what I could add. I consider the principles enunciated as very good. I think it may be summarized under three heads: First, having a good map of what is underneath the streets, knowing what you can do and what you can do at a certain moment; second, giving one notice to all the companies interested when work of general resurfacing is to be done so that they could do their work at the same time that the streets were done, and, third, providing a permit for any cut to be made in the street, and imposing a rather heavy price for the payment of the restoration by the Street Repair Department, so that the companies would be induced to make all their repairs at the same time, and make as few repairs as possible. (Applause.)

CHAIRMAN PARKER: Gentlemen, last night we missed the paper of Commissioner Marker, and its discussion by Col. Stevens, because Commisisoner Marker was faithfully attending to his duties elsewhere. We do not take serious offense at his action because he was attending to his duties, and we like, as you all do undoubtedly, to encourage that effort on the part of a public official. Therefore, with the approval of the President, I am going to introduce now a paper which should have been read yesterday afternoon. It will keep you a very little time, and I think it will be well worth your while. Mr. Marker's

address was to be on the development of a plan for a state road system. Mr. Marker is the State Highway Commissioner of Ohio.

THE DEVELOPMENT OF A PLAN FOR A STATE ROAD SYSTEM

By JAMES R. MARKER

State Highway Commissioner of Ohio

I have been asked to read to you, today, a paper on the "Development of a State System of Highways," and I have responded to this invitation not only with a due appreciation of the honor and courtesy extended, but in the belief that, as Commissioner of Highways of this State, it is my duty to meet and confer with all public and civic bodies interested in the establishment and development of inter-county roads and highways. In cooperation there is strength and unity of purpose, and from just such gatherings as this, permitting wide discussion and broad exchange of ideas, not only myself, but every other public officer charged with the construction and maintenance of a great road system, finds encouragement and hope that in the not far distant future, the highways of America will have reached that stage of perfection which many of the older countries long since attained.

When one stops to think of the comparative infancy of this continent, most remarkable progress has been made. It is but in recent years that any concerted effort has been made to improve our roadways for continuous interstate traffic. Time was when men having to do with the building of roads had an eye single to that particular community in which they happened to reside. It never seemed to occur to them that the upbuilding of their own community depended largely upon its accessibility to and from other communities. And so, many highways were originally built purely as a matter of local convenience. Usually the line of least resistance was followed. In this respect, our early pioneers differed from the early road builders of older countries where, with a more centralized form of government as against our state system of individual government, road building was largely conducted under government supervision. As partial proof of this assertion, we find that in the long ago, "All roads led

to Rome." In this day and age, we are striving to have "all roads lead to everywhere," and we insist that all roads shall be good roads.

While my work in a practical sense is confined to Ohio, yet what I have to say applies in a general way to all of the other states of this Union. Our work is nation-wide and it deserves the enthusiastic support of men and women of every walk of life. We are only just awakening to the real importance of the establishment of a national highway system, and every municipal, county, state and territorial government is hastening to establish a record. It may be well to briefly review in consecutive order at this point, the various eras of highway travel in this country of ours:

First, we had what may be termed the wagon and stage-coach age. Then followed that period when the canals and waterways of the country were largely used for transportation purposes; following this, the genius of Stephenson made possible the building of the railroad, and it was then thought the acme had been reached. This method of travel was quickly improved upon through the wizardry of Edison with the car propelled by means of electricity. And now we must deal with the automobile and truck, so that after all we are brought back to the roads and highways and confronted with the necessity for their immediate improvement.

While, perhaps, the farmer receives the greatest benefit from a uniform system of highways, yet the man behind the steering wheel, who wants to travel from Cincinnati to Columbus or Cleveland, or between the other cities of the state, is the one who is indirectly responsible for the present sentiment in the direction of good roads. In this state, sentiment has been crystallized by the Ohio Good Roads Federation working in conjunction with the various farmers' granges, the automobile clubs and the chambers of commerce of the various municipalities.

The Ohio Good Roads Federation was organized some five years ago, by a number of public spirited citizens, and while at first it received but scant support and its meetings were but poorly attended, the enthusiasm of its members for good roads was most vigorous, and finally the movement spread all over the state until now nearly every man, woman and child inhabitant has taken up the

fight for an ideal road era. Several excellent good roads laws owe their passage to the work of the federation. The "Braun Law" which provides for the construction of roads by the county commissioners, is one of the most important. The "McGuire Law" is another. It entirely reorganized the state highway department, and instead of that department now building an insignificant section of roadway here and there through the state as was formerly done, this law provides that every piece of road improved by the aid of state funds shall be a component part of a state-wide system, and of such importance as to warrant the use of such state funds.

The city of Cincinnati, for example, does not object if she is taxed in a small measure to assist in building a road from here to Dayton, even though that road is not in Hamilton County, provided, however, that it is a direct route and always available for use by the residents of this city. But Cincinnati did object, and strenuously, too, when compelled under the old law to assist some wide-awake (?) county commissioner in the financing of road construction which had for its principal object easier transportation between his own farm and a nearby grocery.

The new highway law attempts to do away with the latter or "individual" method and install in its place the former or "public" plan. To the end that you may fully understand some of its more important provisions, I take leave to quote the following sections:

Section 8.—Within sixty days after the passage of this act, the county commissioners shall, upon request and under the direction of the state highway commissioner, cause the county surveyor of each county to make an accurate map or maps of the county of sufficient size to show distinctly the rivers, railroads, streams, township lines, the location of the cities and villages and public highways of the county, which highways shall be given a designating name or number; the original of such map or maps shall be carefully preserved among the files in the office of the county surveyor and a copy or blue print of such map or maps shall be forwarded to each board of township trustees in the county by the county commissioners immediately upon its completion, which copy or blue print shall be returned to the county commissioners with the statistics and information provided for in the following section. The county surveyor shall be paid from the county fund of the county $5.00 a day for actual time so employed and his actual expenses.

Section 9.—Immediately upon the receipt of the copy or blue print provided for in the preceding section, the township

trustees shall proceed to denote the relative value of each road, in the township in consecutive order as a used highway, the kind of traffic over such road, as well as the number of miles, and the material used in the construction of improved roads when constructed, and their present condition, together with such other information as may be desired by the state highway commissioner. These statistics and information must be compiled upon blanks to be furnished by the state highway commissioner and filed with the county commisioner within thirty days after receiving such blue prints and blanks. The township trustees shall be paid the per diem allowance by law for their services, for the actual time so employed and the same shall be paid out of the road fund of the township, which shall be in addition to all other compensation allowed them by law.

Section 10.—The county commissioners, with the assistance of the county surveyor, shall compile from the statistics and information furnished by township trustees upon blanks to be furnished by the state highway commissioner, statistics and information concerning the roads of the entire county. They shall also specify what roads are national, state, county, toll, township or otherwise. They shall within one hundred and twenty days from the passage of this act, file the statistics and information specified, together with a copy of the several blue prints or maps, with the state highway commissioner and may include in their report such additional information as they may deem of value, a copy of the report to be kept for record in the office of the county commissioners. If the county commissioners or township trustees fail to comply with the terms of this section, relative to maps and statistics, the state highway commissioner shall proceed to have the same done and deduct the cost of the same from any appropriation for road building which may be or may become due the county from the state.

Section 11.—It shall be the duty of the state highway commissioner and his deputies to determine from the statistics and information furnished the state highway commissioner, the relative importance and value for commerce, of the various public highways of the entire state. They shall designate by name and number the main roads of the state which shall be known as "inter-county" highways; and the parts thereof in each county shall be designated so as to form as near as practicable continuous and connected highways and shall designate the order of their relative importance within the county. They shall begin work as soon as the necessary information is furnished the state highway commissioner, and shall complete the work, and file their report with the governor within two hundred and forty days from the date of commencing work unless further time be granted them for such purpose by the governor. So much of such report shall be printed under the direction of the state highway commissioner as he may deem necessary and a copy thereof shall be immediately furnished the board of county commissioners of each county of the state and shall be carefully preserved in the office of the county auditor thereof. After the filing of such report, the state

highway commissioner may, subject to the approval of the governor, designate additional roads as "inter-county" highways.

Section 13.—Each application for state aid in the construction, improvement, maintenance or repair of highways shall be accompanied by a proper certified resolution of the county commissioners or township trustees having jurisdiction of the road to be constructed, improved, maintained or repaired, stating that the public interest demands the improvement of the highway therein described; that the description does not include any portion of the highway in the limits of any municipality. Provided, also, that when all the inter-county highways within a county have been improved to the standard specified by the state highway commissioner, then the appropriation may be used, in the construction, improvement, maintenance or repair of any road within such county. Each application for state aid shall also contain an agreement on the part of the county commisssioners or township trustees, having jurisdiction over the road, to pay one-half of the cost and expense of surveys and other expenses preliminary to the construction, improvement, maintenance or repair of said road.

In compliance with the foregoing, and other provisions of this act, the State Department of Highways has been steadily engaged until we are only just now about ready to file with the governor of the state a report designating a state-wide system of "inter-county highways." The county surveyors and commissioners were required to arrange in numerical order and in the order of their relative importance, all the roads in their respective counties. These county reports were subsequently filed with the State Highway Department.

In the meantime, the engineers of the department had prepared a complete road map of the entire state, drawn to a scale of three miles to the inch, showing all the located roads, the sum total being some 89,000 miles in round figures. With the filing of the reports of the surveyors and commissioners in a given block of counties, say eight or ten, the work of transposing from these local maps to the large state map was begun, the roads in each county being named and numbered in the relative order of their importance in the same general manner followed by the county officers, but on a broader scale. Thus, while the county officers might return say 20 important thoroughfares, it became our duty to select from these, five to ten of them to conform with our inter-county system based on data at hand from adjoining counties.

In other words, we were confronted with the arduous task of selecting from all this mass of information, the main arteries of the state which "shall be known as 'inter-county highways,' and the parts thereof shall be designated so as to form as near as practicable continuous and connected highways and shall designate the order of their relative importance within the county."

This work was commenced by connecting the main market centers in one county with the principal market centers of the adjoining counties. In probably 50 per cent. of the mileage of this system, it was a simple matter of transposing directly from the county maps to the large state map, but in the remainder of the system various rules had to be formulated and applied to determine the location. For example, a given road leading from point "A" in one county to point "B" in another county might be classified in the first county as 20th in importance, while in the second county it might be classified as first in importance, the difference in opinion, of course, being due to local conditions. This difficulty is only one of many encountered and must be expected when entirely different routes are selected by different local authorities. It is quite obvious that the department can view a situation of this sort from only one angle, that of compliance with the general scheme of an inter-county system.

In the determination of a particular route, the following elements were considered and applied:

a. Distance between terminals.
b. Intermediate points and public convenience to be served by each route.
c. Alignment.
d. Grade.
e. Availability of road metals.
f. Distance from a parallel railroad.
g. Cost of construction.
h. Cost of maintenance and repair.
i. Historical prominence.
j. Elimination of danger to traffic.

I do not deem it necessary to tire you with the details of the various phases suggested by the foregoing questions. The occasion is well served by merely calling your attention to them in passing.

Following the solution of the problems arising from so

many conflicting suggestions as to proposed routes in the various counties, the designation was further extended and transposed to the state map. After this was completed thus far, the county commissioners were communicated with, either by mail or in person, and were advised in complete detail in relation to that part of this tentative system embodying their respective counties. The commissioners were urged to make recommendations and suggestions and to signify their approval or rejection of the plan proposed.

This part of the program is just about completed and the department is now ready to finish some minor details and present the system to the governor for his approval. The designation of the system of inter-county highways will then be a reality and will comprise approximately 9,000 miles of public wagon roads or about 10 per cent. of the mileage within the state over which I estimate 90 per cent. of the traffic will be carried. This final report will name and number the roads, giving the length, width of right of way, width of metal, if any, condition of road, kind of traffic, proximity to gravel pits, stone quarries and paving brick plants, and such other information necessary for the construction, improvement and maintenance and repair of parts thereof.

I do not profess to say that each and every mile of this system as proposed will stand the tests of feasibility and practicability, for it would be physically impossible to perfectly locate a system of such magnitude. It is but the result of a strenuous effort to solve a very serious problem, which does not admit of exact and positive solution, like a problem in geometry, but contains such indeterminate elements that to solve it perfectly is given only to Omniscience.

Just as the "proof of the pudding is in the eating," so the correctness of this system will be determined at the time when any part of it is proposed for improvement. There is a saving clause which, if added to our present law, will permit of such changes in the system as will be found necessary at the time of improvement. It should read as follows: "After the designation of the 'inter-county' highways, the state highway commissioner may make such alterations, additions and elimination' in them as may meet the approval of the governor."

While the previous matter so far discussed in this paper is important and is necessary, yet of what avail is it if we stop at this point? Our ideals may be ever so high, but if proper steps are not taken to realize these ideals, our work will have been in vain. In other words, what the Buckeye citizen wants and is now demanding, is more better roads.

The Highway Department, since its beginning in 1904, has contracted for $3,462,753.86 of road construction, over half of which has been let in the last seventeen months, or during the incumbency of the present commissioner. This money includes that raised by the state from two sources, viz.: appropriation and automobile license earnings, and that raised in the counties in which improvements were made.

The first state aid given to the counties was in 1905, when each county received $113.63. In 1906, each county received $1,704.54; in 1907, $1,704.54; in 1908, $5,000; in 1909, $5,000; in 1910, $5,000, and in 1911, $5,000. Since 1909, these sums have been augmented by the automobile license earnings which were for each county in 1909, $529.29; in 1910, $1,348.34; in 1911, $1,822.34, and in 1912, $2,500.

Thus you may perceive that our state has progressed slowly but surely, feeling her way carefully and spending her money judiciously until the present time.

There are no further reasons to prevent the state from proceeding with the intent of the McGuire law, and entering into the "game" on a large scale. All preliminary steps have been made and Ohio is now ready to take her place with the foremost states of the nation in road construction.

This year, I am going to request the Legislature to appropriate $1,760,000, or $20,000 for each county, to be expended under our present law, which provides that the county pay an equal amount. Assuming this program is carried out, I feel safe in predicting an expenditure in road construction of not less than $3,000,000 and possibly $4,000,000, depending on the financial condition of the various counties. Until, and including the present time, all moneys raised by the state have been divided equally among the counties and I favor that method for the year 1913, when state appropriation will be the main source

of revenue. But I favor the enactment of a law by our next Legislature which will provide for a ⅛-mill levy to apply for road construction in 1914, and thereafter, 25 per cent. of which shall be used to improve 6 of the main roads of the state, and 75 per cent. to be applied as are the present funds.

Those counties which contain the larger cities would then receive in road construction an amount more commensurate with the money raised by reason of their heavy tax duplicates. So much for the distribution of funds.

The next question presenting itself is one relating to the selection of the particular type of road for each location. The question is frequently asked, "What kind of road construction do you recommend?" And while the questioner does not realize the question is just as absurd as one asking a physician what kind of medicine he prescribes, yet it is. The answer depends upon the person who is the patient in the latter case, and upon the road, the patient in the former. In the selection of a suitable type for the particular construction, the following should be taken into consideration.

a. Kind of traffic.
b. Availability of road materials.
c. Cost of construction.
d. Available money.
e. Proportion of improved roads to unimproved.
f. Cost of maintenance and repair.
g. Supply of contractors equipped for each type of construction.

Personally, I do not favor a wholesale investment in any new type of road metal or an indiscriminate expenditure in the various and numerous binders which are thrust upon the market. A public official should be just as vigilant in the disbursement of public funds as he would be in the expenditure of his own private purse. My views on this subject might be expressed in the old quotation, to paraphrase it in a slight degree:

> "In *roads* or fashions, the same rule will hold,
> Alike fantastic if too new or old.
> Be not the first by whom the new are tried,
> Nor yet the last to lay the old aside."

The problems of road construction are small and insignificant as compared to those of maintenance. Until

within the last decade, no attention whatsoever had been given to this very important question. In former days, when a road was constructed, it was considered as "done for all time," but not so at the present. The change of traffic conditions makes it mandatory and in keeping with good business economy to provide for maintenance at the same time the "closed road" signs are removed at each end of the improvement. Our present highway law provides that the state maintain and repair those roads improved by the aid of state funds, the state and township each paying 25 per cent. and the county 50 per cent. This law is impracticable. It requires too much "red tape" for a small amount of work, and furthermore, many townships and some counties have depleted road funds not anticipating expenditure in this direction.

The state should maintain and repair all the inter-county highways constructed by it, and any others which have been constructed by local authorities, provided, however, that they be brought up to such standard, as may be approved by the Highway Department. The entire cost should be paid by the state from the resources derived from the sale of automobile licenses. This year they amounted to $220,000 and I am of the opinion that they would increase fast enough to provide for the completed upkeep of the inter-county system as portions thereof were constructed and surrendered to the state.

These recommendations if heeded, will insure the complete improvement of the inter-county system and provide for the maintenance of the same. While it is a big problem and may meet with disapproval from local authorities, yet every state and county which has a complete system of well improved highways has imposed the authority for the same in one centralized head. The state should only assist in an advisory or directory manner in the improvement of those roads which do not form a part of the "inter-county" system. With all due regard to "home rule," these should be left in the control of the local authorities. In short, this plan contemplates the complete control by the state of the construction, maintenance and repair of the "inter-county" system, about 9,000 miles, whilst the counties shall have the same jurisdiction over the roads of lesser importance which comprise some 80,000 miles.

In covering this subject, I have deemed it not out of place to give a brief resume of the work of my department, not with a belief, however, that it is perfect, but hoping that perhaps our experience might be of some little assistance in this, the grandest and noblest movement of the twentieth century.

CHAIRMAN PARKER: Gentlemen, before Col. Stevens comes on I want to make a further announcement to you, and that is that when you came in this afternoon there was handed around to every person here a ballot, which is the same as I hold in my hand, and on which you are to give your choice of three subjects for general discussion on Friday morning. It is very important, from my point of view at any rate, that every man fill out that ballot, because the general questions are of very great importance, and that is the way to determine what you really want to talk about and have a chance to talk about in the discussion with others. Therefore I hope you will be very particular to mark your choices, 1, 2, and 3, on this ballot, according to your desires as to the subjects to be discussed.

I think all know Col. Stevens. It is not necessary for me to go into particulars of his career or to introduce him.

COL. E. A. STEVENS (State Highway Commissioner of New Jersey): Mr. Chairman:—The importance of planning a state-wide system of roads—and, I may add, a nation-wide system—upon correct principles cannot be exaggerated. Mistakes in building a road on a wrong location are costly and there is too much to be done to waste a single cent of the funds available. Don't quote New Jersey as an example of a state that has produced a fairly satisfactory state system without laying out a system. I can assure you that while such a system has not been put on paper until very lately, the policy that has governed the work of the state has been based on the idea of providing such a system.

1. The laying out of a county road system is a most important feature in the intelligent distribution of state aid and state highway planning.

2. The present relative value of roads may very well be designated, but it will in most cases change with improvement.

3. The duty set the commissioner of determining the relative importance of roads "from the statistical information," is an impossible task. This the author points out later. I would not refer to this point except for the reason that such imperfections mar an otherwise excellent law and should be avoided.

4. The ten points deserving consideration in selecting state highways seem to me generally well chosen. I cannot, however, see why the author chooses the distance from a parallel railroad. I should call this "accessibility of shipping points," but we probably mean the same thing. I also fail to catch the importance of "historical prominence." The subject is not one for romance or history but a very plain work-a-day problem. Preserve historical monuments, etc., by all means, but not at the expense of efficiency.

On cost of construction of state highways I want to say a word. It is axiomatic that no public body should spend money on a road that will not return its cost to the people in some way or another. In new countries like ours we should build first those roads which will make the largest immediate returns and these are the important ones, the state highways.

The author puts the estimate of traffic carried by his state highways at 90 per cent. of the total. I cannot agree with him, or rather our experience in New Jersey would lead to an estimate of some 60 or 70 per cent. for our system, which, like Ohio's, is 10 per cent. of our total mileage.

With us, with a system of state, county and township roads we have approximate mileages of:

		Proposed.	Built.	To be Built.
State	10%	1,500	800	700
County	30%	4,500	3,000	1.500
Township.......	60%	9,000	800	.....
		15,000	4,600	.....

The traffic carried I estimate at 70, 20, and 10 per cent., respectively. The traffic per mile of road would then be on the proposed system 7, 0.67 and 0.167, or 42, 4 and 1. There is hardly a public road in New Jersey which would not return a fair value on an expenditure of $1,500 a mile, if we could thereby secure a road, "smooth, firm, and convenient for traffic at all seasons of the year," as required

by our law. It follows, therefore, that the state highway could stand an expenditure of, say, $60,000 a mile and still make a return for the money spent. In other words the question of importance is: "Are you right in your location?" not: "What will the road cost?" By all means consider the latter, but follow Davy Crockett as to location—"Be sure you are right and go ahead."

CHAIRMAN PARKER: Gentlemen, you have heard from Mr. Stevens, and you will see that his deductions are susceptible of mathematical conclusions. He comes from a family famous for their philanthropic and their mathematical work. His family founded the famous Stevens' Institute in New Jersey, which is one of the most famous institutions of its kind.

[The following is a paper read toward the close of the sixth session, but printed here as a part of the discussion on Commissioner Marker's paper.]

RAYMOND BECK (Chief, Touring Bureau, The B. F. Goodrich Co., Akron, Ohio): While this congress is devoted to the technique of road construction, maintenance and efficiency of service, we have lost sight of a very prime factor for preliminary consideration in planning road building, and that is interstate travel and interstate cooperation by state officials; and this possibly might also refer to inter-county cooperation by county officials.

You are building your small veins of travel first and not your arteries of travel. We criticize the individual effort sometimes made by counties and the individual effort sometimes made by states that do not consider the advantageous connection with some large center or centers of the adjacent state. Large centers, gentlemen, automatically demand good highway connections, but they are not always getting it. I might mention such connections as from Toledo to Detroit, from Chicago to St. Louis, and a great many other similar connections with every city that should be improved for interstate travel for use during twelve months of the year and for wet weather as well as dry. Can't you conceive, gentlemen, the advantage to the individual states that the above interstate connections would make if coupled with good hard roads. You can see these arteries of travel automatically creating

smaller veins and filling them with the good red corpuscles of civilization from the cities. Is this not better than working in circles or squares as individual units?

Several years ago I began the preparation of a large map of Continental Europe, worked out on a kilometer scale and showing in diagrammatic form all the best improved roads in Europe. I first plotted the old roads that were still in excellent condition and as soon as they were incorporated on the map I could see the whole scope or idea of practically every country in Europe. There they had worked out their main arteries of travel first to connect not only the large cities in the individual country, but they evidently got together and planned to connect the large international centers. I then added to this map the newly improved roads up to 1909, and I wish I had that map here to show you now. I know that from an engineering standpoint you would readily appreciate that European roads were planned in advance for the best good as a whole and that their planning was not confined to the local unit system. The local unit was benefited far more by the opening up of the larger centers of population (national and international) so that they could reach the country and the country reach the city, and city reach city. And the basis or foundation of all their good work was the trunk line highways first.

My argument, gentlemen, is that we should not only follow in the footsteps of New York, Massachusetts, Connecticut and other eastern states, who have planned trunk line state routes or highways, but that the state highway commissions and state highway engineers should get together for the purpose of improving interstate highways as well.

MR. REEL: Mr. Chairman, I think the subject that Mr. Beck raises is most important, and, as he says, this has been given attention in the eastern states, like Massachusetts, Connecticut and New York. I can think of no more important idea for these gentlemen from the West to take home with them than this very idea of through interstate routes, because it also has a very direct connection with this idea of federal aid which we are all going to be up against before we realize it.

FOURTH SESSION

Wednesday Afternoon, December 4

CHAIRMAN PARKER: This afternoon, gentlemen, we are taking up a very important subject, and Mr. Murphy from Omaha is going to give you a paper which for originality I have no doubt will be unsurpassed in this meeting; and I take it that the views of such men as Mr. Murphy will be of great value. This paper is to be answered in the first place by Mr. Rablin, whose natural attitude is on the other side. It is hardly necessary to introduce Mr. Murphy to you.

THE CONTRACTOR'S POINT OF VIEW

BY HUGH MURPHY

Public Works Contractor, Omaha, Nebraska

I have been requested by our President to state to you the problems of the contractor that are met with today in the construction of roadways for the states, counties, cities and villages throughout different parts of the country, from my viewpoint.

As this convention is composed of practical and experienced men in the building of roadways, all of whom should speak the language of the same tribe—by which I mean the language of road building, and when plainly written in specifications and contracts there should be no misunderstanding between the members of the tribe, unless some members do not want to understand—so without any preliminaries I will proceed to state the proposition in some of its different phases.

1.—As to legislation authorizing construction of roadways for the states, counties or cities, which is ostensibly prepared by the officers of the states, counties or cities, as the case may be, but in reality, as is too often the case, representatives of specific brands of material or patented pavements have influenced the legislation so as to permit of designating patented pavements and specific brands of material to the exclusion of others, and vest the directory and discretionary powers in other officers over the engineer. This opens the contest as to what specific brand of material or patented pavement will be designated, and too

often without consideration for other materials equally as good, and many times, better. There are other hurdles met with in the progress of the work that can only be jumped by satisfying the discretionary direction, decision and approval of the supervising officer of the work. And here let me say, that the engineer who is bending his every effort to bring about the construction of better roads and maintain open specifications and competition, and who stands for justice for the contractor as well as for the property owner—the fair minded contractor can have only the highest regard for his ability and full confidence in his integrity, and likewise for this organization, the first in the country that permits the contractor to meet with the engineers and other officials that compose it, for a free and open discussion of whatever nature, pertaining to the building of roadways, shows that the contractor, engineers and officials are coming to a better understanding of their relative duties and responsibilities.

2.—Let us not overlook the banking interests who frequently get their oar in on legislation and have provisions drafted so that the contractor does not receive his pay for the work until long after the work is completed; and in cases of contest or litigation leaves the contractor to hold the bag and pay the freight.

3.—A contractor of paving work who does not eat from the hand of the interest that controls certain specific brands of material used for pavement, or who is not licensed by the owners of certain patented pavements which have been named in some specifications to the exclusion of all other materials, is not permitted to bid upon roadways specifying those materials exclusively. This deprives a legitimate contractor of an opportunity to bid upon public works and deprives the public of the benefit of competition in the bidding for construction work. Why is this? Is it because this specific material is a better quality than other like material? Or is it because this patented pavement is better adapted to perform the service than other pavement of like character, which can be constructed for less, if the field is open for all competition? Why is it, when these specific brands meet competition in the open specifications that they are sold for 25 per cent. less per yard than when they are specified

exclusively? Who shares in this extra money between the legitimate cost of paving where it is open to competition, and the price paid for the materials and patented pavement that are exclusively specified?

4.—To illustrate, I will quote the following extract from a specification recently issued by a city which fell for the song of the only specific material to the exclusion of all others:

> The asphalt to be used in this work shall be either Gogo asphalt from Hoko Lake located in the Monkey Ranch in the Mountains of the Moon, or the Soso asphalt from Soso Lake located in the Mountains of the Moon beyond the Monkey Ranch.

And this in the face of the record made by the courts from the Atlantic to the Pacific Coast from the year 1894 to 1900, notwithstanding these provisions, asphalt other than Gogo and Soso was adjudged not only equal, but in cases superior to them; and most cf the cities of this country wiped out this exclusive clause and opened the specifications for other asphalts. But recently the men from behind have been coming to the front and singing the same old charm song in many cases with the same old results of closing the specifications.

5.—Creosoted Blocks.—Some of the interests for this class of pavement have a printed stereotyped form of specifications which they have had adopted by cities where they have induced them to specify their pavement, yet these specifications require an oil which cannot be produced to meet its requirements, and if it were possible to meet the requirements of the specification, could not be produced as a commercial commodity; and the contractor outside the circle who takes any of this work is steeple-chased over the hurdles and up against the real thing by the manufacturers or dealers of this oil in this country and must finally forfeit his contract and give up the game because he cannot purchase the specified impossible material to perform his work; while if any of the licensed contractors take the work they can use a material, although it does not meet the requirements of the specifications, for the reason that there is no organization which has the men and means similar to the creosote oil organization to persecute them because they are not able to furnish a material that is not obtainable in the market.

6.—Another example is an extract from a specification where the charter prohibited the naming of material specificially and they endeavored to frighten away competition of bidders by establishing a vicious standard carrying with it a threat of litigation so widely based that if you did not pay them a prohibitory price for their special materials and took the work and used a material other than their's, there would be something doing under this provision, and reads as follows:

It is hereby specially agreed by the contracting parties that the asphalt pavement shall be equal to the best asphalt pavement heretofore laid in any one or more cities of the United States.

Very simple, and placed there for an insurance to the property owner that he would get all that was coming to him, but which speaks very plainly, in the language of the tribe, to the contractor that did not use their material, that if he laid that pavement with another asphalt he would have a lawsuit on his hands to prove that the street or streets that he laid under that contract, was equal to some street in Portland, Oregon, in New Orleans, or in Portland, Maine. He would be required to employ experts and send them to these three different cities to make their investigation, and then return to the Missouri River town to give their testimony at the trial of the case, and all at an expense to the contractor perhaps exceeding the total price he received for the work, and the likelihood of having the case set over from year to year and the expense climbing higher each year.

7.—It is self-evident from these extracts that the specifications containing these, or like clauses, do not open the work to competition for different materials, nor permit contractors to bid on the work, who are not specially licensed by the owners of these specific brands or patented pavements, and thereby wiping out competition of all character and blasting what they call the open door and square deal to the contractor outside the breastworks and to the property owner that pays for the excessive cost of the work.

8.—What is the cause of these and like provisions in specifications for road building? The owners of these specific materials and these patented pavements have had the ear of legislatures in states, as well as many of the

engineers and executive officers that have to do with this character of work. They have been generous in the expenditure of money for promotion and for minstrels to sing the song to obtain their adoption; and when these materials have been specified to the exclusion of others, they are reimbursed for their expenditures by the additional price they receive for same.

9.—Another one of the problems, that is no small obstacle, met by the contractor in the construction of roadways today are certain provisions and stipulations found in most of the specifications for work in the different cities. These clauses are similar to those in the specifications made under the rule of Boss Shepherd of Washington, Tweed of New York, and other bosses who have likewise held sway in other cities in their day, were made to serve their purpose of grafting or ruining the contractor. These clauses have been innocently copied in specifications extensively by engineers throughout the United States, and should be removed from every specification, and have been removed by the organization for the standardization of paving specifications as far as they could go to date.

10.—Another clause: Observe the following instructions to bidders in certain cities at the present time. In these cities the total cost of the work cannot exceed the total estimate of the engineer. The specification reads as follows:

> Bidders must satisfy themselves by examination of the location of the proposed work, its seeming advantages and difficulties, and by such other means as they may prefer, as to the cost thereof, the accuracy of the accompanying estimate of the engineer or quantities, and shall not thereafter dispute such preliminary estimate of engineer or assert any misunderstanding in regard to the nature or amount of work done.

The man who wrote it, whether he were an engineer, commissioner or member of some board, could only have intended to protect his want of knowledge of the work that was proposed to be let, his doubt as to the accuracy of the engineer's quantities, or possible contention of the contractor in the event that the total cost of the work might exceed the estimate of the engineer. You will note there is nothing said if the cost of the work exceeds the amount estimated that there will be any recourse for the contractor for the payment of the excess. It is simply a barricade

that is put up by those who have charge and supervision of the work to save their faces in case of a mistake or a desire to be unfair.

11.—Another provision is where they say that any inconsistency between the plans and specification must be inquired into a certain time before the letting, in writing, but there is no provision for any answer before letting the contract. This means that you can call the angels from the depths of the deep but it does not follow that they will come up when you "hollér." It is a form of fairness without any substance, for after the bids have been received the bidder must abide by the decision of the board without recourse.

12.—Another clause is where the judgment of those who supervise may come in to play:

Any work not herein specified which may be fairly implied, as included in this contract, of which the board shall judge, shall be done by the contractor without extra charge.

This speaks for itself. If you are bidding on a job per plans and specifications and there is a part of the work that is neither in the specifications nor in the plans and they wish it done, you will have to do it without any pay. It may be a case where they are trying to cover their own shortcomings, it may be a case where they are grafting, or it may be a case where they want to put it on you for interfering with their friends and themselves in taking the contract.

13.—Patent Clause.—It reads:

All fees for an invention or patented invention are to be included in the price stipulated in this contract, and to protect and save the city harmless from all such fees and claims.

If the city specifies a piece of work that is covered by a patent, and throws it open and invites the public to bid on the same, it should be their duty, and not th› duty of the contractor to stand the fees for patents, otherwise the contractor would not be able to tell what price to include in his bid in order to meet the royalty or the claim for damages unless he was a licensed operator of the patentee. If he were a licensed operator of the patentee, why, he would be the sole bidder on the work, and there would not be any competition. Therefore, the city should protect the fee and claims of any patent where a patent is used, and leave the work open to public competition.

14.—Here is another clause that is a "lulu." It reads as follows:

> It is mutually understood and agreed that the particularity with which the quality of the material and workmanship to be required is set forth as to some items, shall not except others not so minutely described, from like excellence, but they shall rather emphasize the importance of like attention to them, since the intention is to have only first-class material, each of its class, and the best workmanship throughout, and the spirit of the agreement carried out as to the price per any item in place embracing all incidental cost thereof.

In order that a contractor may interpret this clause he would have to be endowed with occult powers of the mind reader and fortune teller to penetrate the future and name and know the particular persons who would be in charge of the work from start to finish. He should know the varying kaleidoscope views of their minds; the effect of the sun, air, light and sound upon their thoughts, and the mythical spirit that governs their actions in order to foretell the directions they would give as to the manner of doing the work, their judgment as to accepting material, and their decision as to what would constitute an excellence in completed pavement.

15.—Here is still another clause that appears in certain specifications:

> The contractor shall not be entitled to any claim for damages for any hindrance or delay from any cause whatever, in the progress of the work, or any portion thereof.

It is our proud boast that the law of our land does not permit any one to take the property of another without due process of law and full compensation—except the property of a contractor in the construction of roadways where his property may be taken from him under this clause by the damages he suffers, without any redress or compensation. In a game of three-card monte, you put up your money and can turn the cards; but in this game you put up your money and are not permitted to touch or turn anything, or even have a "look in."

16.—These problems are but some of the causes that give rise to friction, disputes and contentions that the contractor meets with in the construction of public roads; interpretation of other clauses of the specifications made by officials regarding material for use in the work where no standard tests are provided, but are subject to their approval; also the discretionary powers, which are vested

in the officials as to the time, place and manner of performing the work, are causes that give rise to further friction, disputes and contentions. They may be the honest opinion of the officials, or may be intruded and enforced for the purpose of graft.

I have stated that these are some of the problems that cause friction, contention and trouble between the contractor and the officials in the construction of roadways, and the question now is, "What shall we do to be saved?"

In my opinion the following suggestions will minimize the cause of friction and contention between contractors and officials in the construction of roadways.

The officials whose duty it is to make specifications and contracts for the construction of roadways, should eliminate all tainted provisions therefrom, providing for the possibility of graft or ruin policy in the execution of the work to be constructed.

By tainted clauses I mean those clauses that limit the competition by giving advantage to specific material or patented pavement, or that give power to officials to make interpretations of specifications or use discretionary power that could be definitely specified and be determined before the letting, so that the contractor would know definitely what would be required and what his compensation would be.

First, they should investigate all conditions of the work to be constructed. The plans should be complete with all necessary details for the construction of the work. Proper tests should be established for all classes of material that enter into the construction of the work, with liberal limitations so as to admit all material in that class suitable for the work and available in that market, regardless of and without mentioning their name, brand or source of supply.

Before any general specifications and standard tests are adopted, all contractors and material men in that section of the country at an appointed time, should be invited to be present and file their suggestions and objections in writing as to any manner, methods or requirements of the proposed specifications, or the tests that in their opinion will admit of genuine and liberal competition between the materials of the different classes, and between bidders for the work.

A standard test for a material should not be prescribed so that only one or two particular materials could comply with the test; but it should be liberal within its limits, so as to admit all within that class of materials that would be suitable for the making of a first-class roadway, whether it is oil for creosote block pavement, vitrified brick block for brick pavement, asphalt for sheet asphalt pavement, bitumens for impregnating macadam, or bituminous concrete, broken stone, sand and cement for concrete, or any of the other materials that enter into the construction of roadways, so that when the bids are received the contractors may furnish any material that will meet the requirements of the tests, regardless of any name, brand or source of supply.

With these provisions surrounding the letting and execution of a contract, it becomes, in a measure, automatic. The contractor or his representative should have the right to be present when the tests are made regarding any of the materials, and before any are finally condemned. The custom is prevalent today with cement manufacturers, to furnish a certificate of tests giving lot, number, etc., with each shipment. It might also be a good policy to require a certificate from the refinery furnishing asphalt or bituminous mixtures, to be used in any way with the construction of the work, giving results of the tests as required for that class of material in the specifications, likewise for all other classes of material for the work.

With these positive and definite means for determining the suitability of the material that enters into the work, you will have removed many of the causes for friction, disputes or troubles regarding the material to be furnished.

With the adoption of the suggestions herein made, it is fair to presume that fair contractors, dealing with fair engineers and city officers, would not experience the friction and trouble so commonly complained of and that contractors might pursue the calling of road building with no more hazard or worry than people who pursue the calling of any other legitimate business. Yet I do not wish to be understood that the adoption of these suggested remedies into specifications and contracts would convert dishonest men to honest men, but it would remove many of their opportunities for acting maliciously and dishonestly. Even the general acceptance of these suggested remedies

to cure the evils complained of, will not adopt themselves into specifications and contracts, no matter how fair, no matter how honest, no matter how anxious and willing the fair-minded and able engineers of this country would be to adopt these, or other changes, to bring about the square deal, open specifications and open competition. It must be borne in mind that there are but few engineers in the country but that are dominated by political officers who out-rank them in the direction of making and adopting specifications; which politicians in turn are dominated by the representatives of specific brands of material, patented pavement and political machine bosses.

Contractors who are independent road builders, contractors who are not tied to any special brands or patented pavements, must get together, and remember in unity there is strength. United we stand, divided we fall. It is then up to the independent contractors of the United States to unite and form a protective association, and by constant vigilance before legislative bodies, local boards and engineers, advocate these changes and bring about the adoption of laws and specifications that will produce the square deal and open specifications; and in these efforts you can depend upon the good will and assistance of all fair-minded engineers; otherwise, those interests that are active, will not only maintain the foothold they have, but will increase it until finally such a thing as an independent paving contractor will be a thing of the past, and will produce in their stead a class of contractors who will be in the same position as the saloonkeepers who are tending bar for the breweries, the breweries owning the building, stock and license under which the saloonkeepers are doing business by the sufferance and grafting of the political boss.

If you wish the conditions remedied, you yourself must cause the remedy to be made, otherwise you should not complain because others do not do for you what you fail to do for yourselves.

CHAIRMAN PARKER: Gentlemen, I do not think that you believe that a mistake was made in asking Mr. Murphy to read this paper. He has given you as honest and straightforward a presentation of the contractor's point of view as it is possible to make. I have heard, of late years,

and have seen and read, articles prepared by contractors of high standing appealing to the public for a fair deal, but I have not heard any that covered the point so well as Mr. Murphy's paper. The answer to Mr. Murphy's proposition is to be delivered by Mr. John R. Rablin, Chief Engineer of the Metropolitan Park Commission of Boston.

JOHN R. RABLIN (Chief Engineer, Metropolitan Park Commission, Boston, Mass.): Mr. Chairman, of course, as an engineer, I cannot be expected to look at this subject from the contractor's point of view; but I really do, I think, consider the contractor, and always wish to. I think he should be considered on all public works.

I am not going to try to answer any of Mr. Murphy's specific charges against the engineers and commissioners. From Mr. Murphy's paper I would get the impression—I don't know whether the rest of you would—that a very large percentage of engineers, commissioners, and other public officials are dishonest and grafters. Now, I may not be well enough informed, coming from down in the corner, as I do, of New England, but I hardly think that is true, and I really don't think Mr. Murphy thinks so either—that the largest percentage of them are dishonest. There are officials in charge of public works, no doubt, who are dishonest, or have been, and have perhaps looked for graft; and there are others who are narrow, not broad enough to have charge of work, not liberal enough in their views. I think all engineers—and by engineers I mean officials in charge of public works—should try to look at all questions that come up, from both sides, and give the contractor a square deal if they can, give him all the leniency they can. But if an official is going to put himself into a hole to do it, he cannot be expected to. You who have had charge of public works, probably know that all contractors are not fair minded men and fair men; they do not treat the engineers fairly. In my own experience, I have had instances where, in trying to be lenient with the contractor because he had made too low a figure for a contract—allowing him to do something not strictly according to the specifications but which surely would not be any injury to the finally completed work, something for his own benefit—I have had, as I say, instances where by doing that the contractor has taken that very thing as a basis for a claim for damages. Now, as I say, there

are contractors, who are not fair as well as engineers. They are not all so; a great many of them, perhaps the large percentage, mean to do their work properly. It is almost an impossibility for either side to live up strictly to the specifications. You have got to use some common sense.

As for the brands, the specific brands of patented pavements: Of course, it is not fair to all contractors to specify a patented pavement because they do not all have a chance to bid on it. But if an engineer, or public official, thinks that he is going to get his money's worth and get something that is better than the general run of unpatented pavements, why isn't he entitled to his opinion? There is no doubt but that some of the patented pavements have considerable merit, and probably some of them are better than the general pavement of the same class that can be constructed without the license of the patentee.

It would be difficult to make specifications broad enough to let in anyone, that is, all kinds of material, withour letting in some that were not suitable, so that it is necessary to limit them to a certain extent. I think the specifications should be as definite as possible, so that disputes will be eliminated and not put up to any one person to decide, and so that the contractor when he is bidding will know what he is bidding on, and then if he does not want to bid he is not compelled to. Public works of necessity must be open to public bidding, and by so doing irresponsible contractors do bid, and they often bid too low a price. Then the trouble begins; and it is just as much trouble for the engineer as it is for the contractor. It is just as hard for him. He does not enjoy it. He would much rather have a contractor at a fair price who is going to make a little money, and get along all right, and who does not have any disputes. It is very much easier.

There are many clauses in specifications for public works which are one-sided, and are put in to protect the commonwealth or the municipality from irresponsible bidders. If a contractor is a responsible bidder, and is doing his work properly, and intends to do his work properly and be fair, whoever is in charge of the work certainly should be fair with him, and not too rigid on these points; and some of these most rigid clauses from the legal point of

view, are necessary, and are required. It is not the engineer's fault. He can't help it. All he can do is if the work is properly done, to use common sense and enforcement. And I think a great many of these clauses are not so much for the protection of the engineer, but for the protection of the municipality or the city against irresponsible bidders. It certainly is necessary for someone to have the power to decide any questions that may come up on public works under specifications. If you were a private individual making a contract for some work, you would not say that in anything about which there was any question, the contractor should decide. You would probably want to decide it yourself the same as the official making the specifications for public work. He would not be doing his duty if he did not make a specification so that he could decide those questions. But, of course, he should be fair about it. He should use common sense about it. And the specifications and the plans should be made as definite as possible to avoid any such questions, in my opinion. As for the percentage of dishonest public officials, in my section, I think it is very small, and, as for the rest of the country, it does not seem to me that there could be so large a percentage and not be more publicity about it. I thank you. (Applause.)

CHAIRMAN PARKER: All public officials are not as Mr. Rablin. His reputation in Boston is such that all contractors feel that they can deal with him without danger. That is not, however, just the understanding that I have as to what Mr. Murphy said. He was obliged to put himself pretty much on the extreme, because the attitude in general is against the contractor. In that I agree with Mr. Murphy. I don't think he intended to imply that the large percentage or even any specific percentage of dishonest officials was included in his proposition.

MR. MURPHY: I wish to explain the comments made on the clauses taken from the different specifications quoted in my paper. I stated that they were conceived and written under the regime of master boodlers and were innocently copied by engineers throughout the United States, and they should be removed. There was no intention in my paper to attempt to discredit the engineers. I have worked continuously with engineers on public works for nigh unto forty years, and I know of no class or profes-

sion of men who are more fair, just and honest than the engineers. (Applause.)

CHAIRMAN PARKER: I think that puts it right, gentlemen, and that is precisely as I understood Mr. Murphy's attitude. Now, we have got plenty of time for a little further discussion, and I think it would be excellent for some of you contractors to say a few words now, and then we will hear from some other official. Mr. Rockwood?

MR. ROCKWOOD: I thank you, but I would like to be excused.

CHAIRMAN PARKER: New York is famous for its modest men. Mr. Ellis, haven't you something to say for the contractors?

MR. ELLIS: I have something to say later, but I am going to save my voice.

CHAIRMAN PARKER: We want your feelings from the heart, now.

MR. ELLIS: Mr. Chairman, I don't think that I can add anything to what Mr. Murphy has said.

CHAIRMAN PARKER: Do you agree with him?

MR. ELLIS: I agree with him thoroughly, and I don't think that anything in Mr. Murphy's paper was intended to be a general criticism of the honesty of engineers. I think it is something that has grown up from old custom, and most of the objectionable clauses in the specifications were written a long time ago, and they have been copied from time to time without any thought or reference to conditions at present or the men who are doing the work, or the engineers who are drawing up the contracts.

CHAIRMAN PARKER: I don't suppose you realize that I represent both sides of this proposition. I have been a public official; now I am one of the thieves, as they say. I will call on Maj. Crosby.

MAJ. CROSBY: Mr. President and Gentlemen:—I have been on both sides of the fence, and it strikes me that it is an unwarranted assumption that all contractors are dishonest, and that all engineers are crooks and rascals, and that no such assumption was intended. There are some incompetent engineers. Very likely there are some dishonest ones, and I think that it may be admitted that there are some contractors who are perhaps in the same classes.

I want to call your attention to the position the public

official is placed in. First, he is absolutely unable to select his bidders. He has to provide for free and open competition which the public demands. Second, he is obliged, for the protection of himself and his client, the public, to see that the specifications shall be drawn so as to absolutely enable him to prevent any successful attempt at rascality, crookedness, or substitution on the part of irresponsible or green contractors. As I say, that places him in a little difficult position. It is quite different from the position of the engineer who is working for a private client and can select with care the people whom he asks to bid on work.

Now, as regards the contractor: I think it well—and it has been my practice to do it wherever I have been allowed to—to consult with the material men, as Mr. Murphy suggests, and with the contractors before drawing the specifications. I have found such a variation in the opinions resulting from that consultation that in many cases I was no better off after the consultation than I was before. In all cases, there were many points which I had to decide and this I did to the best of my ability with due consideration of the information I had received from those who were likely to be interested in the work. In such decisions the responsibility for them rested on me, and I was perfectly willing to assume it; I considered that a part of my duty. If I drew specifications which produced a certain class of work, and that class of work was not what the contractors thought it should be, I submitted to them that the responsibility for it was mine, and not theirs, and, therefore, it was up to them, if they bid on the work and secured the contract, to give me the class of work I had specified and not what they thought I ought to have.

I want to submit that the friction is not as great as might be anticipated from the interest in this meeting. I am reminded somewhat of the story of the man who offered to sell a carload of bullfrogs, but when he came to deliver the carload he told the dealer he had only shipped a half dozen. He said he thought from the noise they made, there must be a carload in his back yard. The great source of friction that I have found between contractors and engineers comes from two causes. One is the indefiniteness of the responsibility—that is, if an organization is not clear cut, the contractor doesn't know to whom to

look for a decision, and there is likely to be friction. He is likely to go to the weaker members of the organization, who are generally the most available, and secure from them opinions which are not decisive. They at least allow him to deceive himself into thinking they are decisions, and then when he follows them he gets into trouble with the higher authorities. There should be no lack of clearness as to who is responsible for a decision, and when there is that absence of clearness the contractor cannot readily go to the proper party for a decision which will be final. The other cause of trouble, and perhaps the more serious, is that after the specifications are drawn, and, as I have said before, drawn with the full knowledge of the engineer as to his responsibility for them, a great many contractors, not agreeing with the clauses of the specifications, attempt to substitute something "just as good." There has been more trouble, in my own experience, from that effort on the part of certain contractors to substitute something that is considered, perhaps honestly by them, just as good as what was specified.

If responsibility is placed where it belongs, and engineers will pay more attention to organization, the delegation of responsibility, and to the publication of information concerning their work, assuming themselves that responsibility belonging to the designer, and then if the contractors will live up to the moral intent of their contracts and deliver what they have agreed to deliver—what the specifications require in the absence of orders to the contrary from the responsible parties to the contract—a large part, if not practically all, of the friction between contractors and engineers will be done away with. (Applause.)

CHAIRMAN PARKER: Mr. Rockwood, will you now say a few words?

A. J. ROCKWOOD (Rochester, N. Y.): Mr. President, last year I came in this meeting as I did this year, right in the midst of a discussion, and I was asked to talk, and I did so offhand, and when I read it later, I found I had said some things I didn't mean; and I found I was very much in the condition of Mr. Murphy, who seems to have given the wrong impression of his views both of the engineer and the contractor. I am a road contractor at the present time. For upwards of twenty-five years I was an engineer; and

I want to say right here that in my experience of something like thirty years, I have never run across but one crooked engineer and he got fired. I promised him he would and he did, and the man that fired him is in this room now.

Mr. Parker doesn't know what he is up against, he is just commencing the contracting end of it. All the trouble is that the engineering profession is so poorly paid, that a man can't stick at it very long. We contractors can afford to hire the good engineers and give them more than they are getting from the cities. There is where the trouble is, and the trouble is most of us have young men interpreting these specifications and interpreting clauses that our grandfathers put in for some reason or other, and there's where the greatest trouble is, in my opinion.

I had a funny experience a little while ago. I won't say whether it was on one of my contracts or some one else's, but the contractor was attempting to give something he thought was just as good, and fortunately he was an engineer and had had more eperience than the young engineer he was talking with. He said, "Hell is paved with good intentions." And the contractor said, "Well, if you stay around here a little while you will think you are in hell, and that is no joke."

My experience has been not that the engineers were crooked, or meant to be crooked, but that the specifications were written so as to take care of the crooked contractor. Now, the crooked contractor is not always crooked from desire, he is sometimes crooked from necessity. He may have been a plumber or a roofer, or something of that kind, and he thinks that there is money in roads, and he goes to building roads. He takes the engineer's estimate and he says, "It can be done for $10,000. I don't want to make 20 per cent., I am satisfied with four or five on the first road." And he usually goes broke on that road. We have had something like that in our state, but the main impression is that the contractor and the engineer both want to be straight. At the present time it seems to me that a great deal of the trouble is that neither the engineer nor the contractor knows how to build a road that is going to take care of motor traffic. The engineer does the best he can, and the contractor opens the road. It doesn't do the business and the engineer has got

to make good with somebody, so he does it with the contractor or with someone else. But my experience with the engineers has been very pleasant. I never had but one engineer in my experience who was crooked, and, as I said, he lost his job.

CHAIRMAN PARKER: I am going to ask that you continue this discussion, alternating between the contractors and the engineers. I am going to ask Mr. Rourke to make a few further remarks.

L. K. ROURKE (Commissioner of Public Works, Boston, Mass.): Mr. Chairman and Gentlemen:—I have been on both sides of the fence. I am now a public official and engineer, and I have been a contractor. I am not a "has been" either. By the way, I did not get the impression from Mr. Murphy's paper that the majority of officials and engineers are crooked. It did not strike me that way at all. He read some quotations from specifications which are now published that a professor of English in Harvard University couldn't interpret the meaning of—there is no question about it. My idea about the thing is that a specification is a guide only, and it should be in the simplest possible terms.

One of the great troubles between contractors and engineers is that the majority of the engineers in charge of work see the work from one side of the fence. For instance, in railroad work, they are paid by the railroad company. In municipal work they are paid by the municipality, and for that reason they get it into their heads that they are dictators, and that they are to put it up to the contractor to do just so, otherwise they will soak him. Now, my idea of the engineer on the work is not that of a dictator, but that he is an arbitrator. These specifications are simply a guide for him to go by; and no man can write a specification that will cover every job in detail. Such a specification has never been written, and never will be written. We can simply write a general guide for the engineer to conduct himself by, and when the argument comes up, no matter whose payroll he is on, he has to work for the contractor just as well as for the railroad company or municipality. He is the arbitrator to settle the dispute. And, as I say, the fault with a great many of the young engineers is that when they settle this, they settle it on a biased basis because they have not had the

necessary practice and experience, and they do not realize what their position is, as an engineer, namely, that they are not the dictators on the job, but they are the arbitrators and the just arbitrators between the contractors and the man who employs them. I thank you. (Applause.)

CHAIRMAN PARKER: I thought you would not be disappointed in Mr. Rourke. I do not see any contractor that I know here, but I would like to hear from some other contractor.

I would like to have Mr. Shirley say a few words to this assembly. He has had occasion to criticize and knock me several times, and I would like to get his reasons for it.

H. G. SHIRLEY (Chief Engineer, Maryland State Roads Commission): Mr. Chairman, I have had the pleasure, like these other gentlemen, of being on both sides of the fence. In my younger days, I started on the contractor's side, and I am now on the engineer's side.

I think that in specifications ordinary common sense should be used, and that is the cream of the whole thing. I have never seen a specification that would absolutely cover the whole job. You can cover many points of the job fairly well, but there are certain things at certain points that you will have to meet that the specifications will not cover. Now, to meet these: There is the point where there is a chance for differences to arise between the contractors and the engineer. I think the specifications should provide a clause stipulating that, should any point of this kind arise, it should be settled before they go ahead; in other words, price per unit, and lump sum price should be decided on. When any contention arises on the specifications, I find that where the great difference is and where lots of friction develops is in the fact that the thing is not settled at the time it occurs. The contractor is in too big a hurry to go ahead and get the work done, and the engineer is anxious and interested in something else, and he says, "All right, we will settle that some other time." When a dispute arises, settle it then, and you won't have so much contention, it is fresh in both of your minds, and you can get together if you use any common sense. (Applause.)

CHAIRMAN PARKER: I am glad, gentlemen, that Mr. Shirley has made the statement that he has—that the

adjustment of the differences between contractor and the official may be settled by common sense.

FRANK AGNEW (Secretary, Road Commissioners of District No. 1, of Mahoning County, Ohio): Mr. Chairman, these gentlemen speak about being on one side of the fence or the other—I happen to be on both sides at once. Of course, the specifications must be a guide. I had a little contract this fall, and I made a mistake in it. The engineers and inspector were there, but that didn't help it any; I had to dig it up and rebuild it again. Of course, that was all right; but what I wanted to say just now was this in reference to this last remark about settling your differences. But I wanted to go one step further: Settle the differences and then have it written down on paper so that you know where you are. We have had old lawsuits hanging up three or four or five years, when these things should have been settled years ago, or would never have come to litigation had agreements been written before the work was done.

There is one thing more that has bothered me—I am rather an official behind the engineer in my capacity—and that one thing that has bothered me is where the engineer writes specifications so that the contractors bid on different kinds of material, and then after the bids are in it is up to the officials to decide which kind of material to use. I think if they specify those different kinds of materials there should be an estimate made of where one kind of material should be used instead of another; that is, say, a difference between slag and limestone. Some may think that slag is better and it does give a chance for a mix-up once in a while, and I think it should be avoided.

CHAIRMAN PARKER: That sounds like common sense to me. Anybody else to take part in this discussion?

RALPH H. PYNE (Contractor, Newport, Ky.): Mr. Chairman, speaking of the contractor and the engineer, I have always found that one of the greatest difficulties has been that the contractor has always looked at the engineer as a mortal enemy, and the engineer has always looked at the contractor in the same way. Personally I have had a very pleasant experience throughout the thirty years of my life as a contractor. I don't mean to say I have never had a dispute over work; I have had many of them, but I have never yet had a personal dispute with an engineer.

Every time that work has been completed, although sometimes I have lost out, I have always been able to shake hands with the engineer, and I have never found a dishonest one. (Applause.)

CHAIRMAN PARKER: That is a good recommendation for the engineer. I will recognize Mr. Kenyon of the United States.

C. A. KENYON (President Indiana Good Roads Association, Indianapolis, Ind.): Gentlemen, he has made a mistake. I am just from Indianapolis.

Over in Indiana we are trying just now to get a good roads law for the state, and in drafting that law we had a good many hearings, and we took the testimony of a good many people in regard to the way a contract should be let and bids received; and after hearing from both sides—the engineers and the contractors—the committee of 25 who drafted the law took this view of it, and I am just going to hand it to you for what it is worth. They said that when a specification was made and was so general that under the general clauses of that specification several different kinds of material might be used, the bidder in bidding should state the particular brand, or kind, and file a sample of the material that he proposed to use in completing that contract, believing that if he did this, many of these controversies that grow out of the general nature of specifications could be settled by reason of the terms of the bid together with the specifications themselves, and a lot of the troubles that we have been discussing and been describing would be done away with.

I ask you if that would not be likely to help a large part of the trouble that exists. Of course, it has been said there are good contractors and bad contractors, just as there are good lawyers and bad lawyers, good preachers and bad preachers, good merchants and bad merchants. It may frequently happen that engineers have no one to associate with except the contractors, and being in daily association with each other, how can you expect one to be better than the other? (Applause.)

CHAIRMAN PARKER: I don't think you have exhausted the subject yet, but if you have nothing more to say, I will go on to the next matter on the program.

H. G. ZELLER (Contractor, Swanton, O.): I have often wondered whether there were any contractors who expected to build roads to come up to the specifications?

CHAIRMAN PARKER: I can't answer that now. I don't believe that a specification for a road was ever drawn that could be literally fulfilled by the contractor.

MR. ZELLER: We don't have any trouble with engineers, not a bit of it.

CHAIRMAN PARKER: Do you import your engineers or are they native products? (Laughter.)

MR. ZELLER: I don't know that it makes any difference. We don't have any trouble with the engineers. The greatest trouble we have had in our county on the road proposition is this: The farmers that live along the roads expect an inspector who never saw a road before to come over and build them one. (Laughter.) The next thing that our people in our county do is this: The commissioners have a right to appoint an inspector, and they generally appoint some political friend or some heavy taxpayer living along the road who has never seen a road built, and of course, you have to do as he says. You have to satisfy the inspector who does not know how to build a road, the engineer does not have time to come out there very often, and that is what we are up against. That is the hardest proposition. We don't have any trouble in getting along with the engineer, the only trouble we have is with the "buttinskys." (Laughter.)

MR. ROGERS: Mr. Chairman, the greatest trouble we seem to have in Michigan with the contractors is that no contractor seems to be able to bid high enough. They bid so low that they go broke before the job is done. I don't think that our engineers are trying to be hard on contractors, and we don't seem to have any trouble in that line, but either the contractors bid with the expectation that the specifications do not mean what they say, or that the engineers are unduly easy, or that they are afraid they won't get the job and want it badly. But that condition I hope will be bettered. I must say, however, that most of our contracts have been for rather small sums, and usually have been taken by men inexperienced in contracting. Some of them knew very little about the work that they undertook to do.

I would say just a word along the line of settling difficulties as they arise. It is a little along the line of a court decision in our state which was over a sewer contract. The resident engineers allowed certain things to proceed day by day which were not satisfactory, and when

the work was finally completed the consulting engineer refused to sign a final settlement for the contractor. The matter went into the courts and eventually to our Supreme Court; and the Supreme Court said, substantially, that if the engineers stood by the work day by day and permitted things to proceed they thereby tacitly gave their consent to that kind of work and would have to suffer for the failure on their part.

PRESIDENT LEWIS: Mr. Chairman, may I take the time to contribute just a word on this general subject? Many of the contractors who are here have doubtless done work for business, railway and other corporations, and I fancy that they have had comparatively little trouble in the way of controversies or disputes. They have had little trouble because the officers of those corporations have been free to adjust difficulties, and even to select contractors, who they thought would be satisfactory and would do the job well. The men you are dealing with in highway construction and other public works are spending public money—money raised by taxation—and you know how jealous the taxpayer is of the manner in which his money is expended. You know what alleged safeguards have been thrown around all contracts where the expenditure of public money is involved. A distinguished attorney in commenting on a contract of the city of New York remarked, "The man or the group of men who drew that contract had no bowels of compassion." Such contracts are often one-sided and perhaps unfair. They have been built up on a long line of precedents which are designed to protect the public and the public money. They are drawn with a view of avoiding taxpayers' actions resorted to by many a contractor—yes, mind you, by many a contractor—as a subterfuge to prevent a rival getting a job, and it isn't hard to find an excuse to grant an injunction on an alleged taxpayer's action. Remember, then, in discussing these questions, that your troubles are not all the fault of the contractor; they are not all the fault of the engineer; they are frequently due to the serious limitations imposed upon both of us because we are spending public money. I have often thought that when a number of miles of road were to be built, or a number of miles of city streets were to be paved, if the engineer or the commissioner had the right to call in three or more con-

tractors and say to each one of them: "We propose to give you enough of this work to keep your plant in operation all through the season, provided you give us a satisfactory price. Now, let us talk business and see what you will do;" the result would be that the state or the city would get that work done for less money than it would under public letting, the contractor would feel that he had a good contract, and the state or city would get value received. But it is safe to predict that the commissioner or the engineer would be denounced as a grafter because no one would believe that he did not have a corrupt interest in such an arrangement. Those are the difficulties under which public officials are working. (Applause.)

CHAIRMAN PARKER: I think Mr. Lewis' words were illuminating, and put this matter fairly where it belongs. In view of the things that are to follow on the program, possibly we had better not continue this discussion any longer, but we will consider Mr. Lewis' remarks as a benediction.

Next on the program is "Plant Equipment," by Mr. F. E. Ellis, Manager of the Essex Trap Rock & Construction Co., of Peabody, Massachusetts. Mr. Ellis, I think, is well known to most of you, and he is well equipped to make a statement on this or any other subject.

PLANT EQUIPMENT

BY F. E. ELLIS

Manager, Essex Trap Rock and Construction Co., Peabody, Mass.

A score of years ago Road Building was a very simple business, requiring only a small amount of plant and very little expense was incurred by anyone who wanted to enter into it, and one in the business could withdraw from it at any time without sustaining a great loss due to the amount of capital tied up in the plant. During the last twenty years, the method of road building has gradually changed, until the plant now required by a contractor is large and varied, and the expense attached thereto is enormously large in proportion to the amount of work done per year.

It has become a business in which one should not enter without considering thoroughly the kind and amount of

equipment required to do the work that he is contemplating, and only after a careful estimate has been made of the expense of plant and the proportionate charges that should be made for the same upon the work on which he is bidding. One must also realize that once in the business, he must remain in it for many years in order to get back the cost of his equipment, or else be willing to take a loss on the sale of it upon retiring. In other words, it is not a business that a man should enter upon with the idea of its being temporary, but with the idea of its being permanent. Failure to understand or obey this principle has been disastrous to many contractors. If the proper plant charges are not made, the contractor is deceiving himself just as surely as did the kind old lady who gave gingerbread to all the children in the neighborhood, and thought it did not cost anything because she had everything in the house to make it of.

The kind and amount of equipment which is required for building a road will vary in the different classes of roads to be constructed, and in order to make a correct estimate of the cost of equipment and the expenses incidental thereto, it is necessary to know the class of road which is to be built. For example, I am going to show you just what it actually costs to equip a road with proper construction plant. The road built was six miles in length, and surfaced with local stone grouted with bituminous binder. The stone was obtained from a quarry which was situated so that the average haul was about two miles. The whole contract amounted to $60,000.00. A contract of this size is considered an average season's work for one gang of men and one set of equipment. I am going to omit from these calculations the cost of small tools, such as picks, shovels and scrapers, and confine myself to larger items of wagons and machinery. The total cost of equipment was $18,240.00 or 30 per cent. of the contract price. The interest on the cost of equipment at 6 per cent. and depreciation at 10 per cent. per year makes a total of $2,918.40 for fixed charges on equipment, necessary to do $60,000 of work per year, or approximately 5 per cent. of the amount of the contract. Most of the expense of equipment was chargeable only to a few items in the contract which included the surfacing. The contract price for these items amounted to

approximately $32,000.00. The first cost of the equipment used in the work covered by these items was $16,-445.00 or 51 per cent. of the work done. The interest and depreciation upon the same amounted to $2,631.20, or 8.2 per cent. of the amount of the work done.

This I believe to be a fair estimate of the amount of equipment and the charges which should be made in order to be safe in estimating upon work of this character. There is hardly any business conducted in which the investment for equipment is so large and the expense due to depreciation and upkeep so great as in road building. Every engineer and contractor in making estimates ought to take these charges into consideration, and contractors who expect to go into the road building business, should make a careful estimate of the amount of plant required and the expense attached thereto. It is not a business in which a man can expect in these days of keen competition to make enough profit to pay for a plant in one season's work, and a man entering upon this kind of work must expect to stay in the business a long time before the equipment can be paid for out of the earnings. Road building machinery should only be purchased after a thorough investigation, especially in regard to the liability of breakdown and the expense of the up-keep. The expense of repairs on road building machinery is very small in comparison with the loss which is occasioned by the disorganizing of working crews due to breakdowns. In deciding upon the purchase of machinery, too much weight should not be given to the item of first cost, as the more expensive machine in first cost may be a far cheaper machine to operate and may be depended upon to do its work day in and day out, where a cheaper machine, although it may not break down, is very liable to do so.

In this discussion of road building equipment, I am not going to make any recommendation. I do not expect that my remarks will meet with the full approval of any of the machinery men or the contractors. We all know that if a man purchases an automobile that whatever kind he purchases, be it a one-lunger or a six-sixty, that particular kind is the only automobile worthy of consideration, and it can travel more miles per day than any other make, with less gasoline and expense of upkeep,

and the same views are taken by a man who purchases road building machinery. I am therefore only going to give you my own views, which are the result of personal experience.

Wagons

Four kinds of wagons have been largely used upon road work. The four-wheeled bottom dumping wagon, the four-wheeled two-horse tip cart, the two-wheeled one-horse tip cart and the four-wheeled slat wagon. The slat wagon offers no advantages over the other type, except they are a little lower and easier to load. This advantage is altogether outweighed when the time lost in dumping and turning around is taken into consideration. The single horse tip cart is very economical on short hauls and for work in contracted space, and for making end and side dumps on embankments, or in hauling stone from the quarry to the crusher. The four-wheeled tip cart hauls and is handled very easily on road work, but the weight being all on the hind wheels it is very destructive to road surface and subgrade, and much time is lost in dumping and righting the wagon. The bottom dump wagon can be used anywhere that the two-horse slat wagon or tip cart can be used, and is more economical than either, the expense of maintaining roadway being very much less than with the other kind. Material can be dumped more quickly, it not being necessary to stop while dumping, and the material can be distributed to a better advantage than with any other type of wagon. Any wagon used on road work should have tires not less than 4 ins. wide.

Road Machines

A road machine can be used to advantage in digging side ditches, scraping shoulders and making light cuts in the roadway. A machine for this purpose should be built strong enough to be hauled with a steam roller or traction engine without danger of breaking the machine, and also be equipped with a steering device, so that the machine may be worked outside of the traveled roadway while the roller or traction engine is working upon the firm traveled way.

Stone Crushers

Three types of stone crushers have been used to a great extent in road building—the gyratory type, the jaw type of the Blake pattern and the jaw crusher of the cam-shaft and roller type. The gyratory type is not very well adapted for portable plants on road work, as the crusher opening is so narrow that the stone requires too much sledging in order to properly feed to the crusher, and the crusher opening is so far above the ground that it requires either a pit or an extremely high dumping platform with a long incline in order to get the stone into the mouth of the crusher. They are also complicated and expensive to keep in repair for work in the eastern part of the country, as it is a long way from the source of supply of the repair parts. For permanent plants where the stone breaks well in blasting, they are a very economical machine.

The advantages of the Blake pattern are the extreme simplicity, there being a less number of reciprocating parts and a less number of bearings which require oiling, than in any other crusher. There is a wedge adjustment by which the crusher opening may be regulated without stopping the crusher. This is an important feature, where enough fine stone must be dumped along the shoulders of the road ahead of the bottom course, as in the case of grouted bituminous work. There is only one tension rod and one spring to keep in adjustment and repair. There are no bearings into which stone chips and dust are liable to enter. This type of crusher I have found to be very economical to maintain and is extremely reliable.

The disadvantages of this type are that for the same size opening, the crushers weigh more than the other type of jaw crushers. They are not so easily transported and handled, the situation and size of the fly wheels in reference to the crusher make it more unhandy to dump close to the crusher than any other type. As a rule the first cost is in excess of the other type of crusher.

The advantage of the cam shaft and roller type crusher is its light weight, which makes it easy to transport and set up, low fly wheels, situated so that the stone may be dumped much closer to the crusher opening than in the

Blake type, low first cost and the quick delivery of repair parts. The disadvantages are that it is much more complicated; has more moving parts, more springs and tension rods, than the Blake type. There are more bearings to be lubricated, and the toggle lever shaft is generally situated so that chips and dirt can enter into the bearings. No adjustment can be made regulating the opening of the jaws without removing the toggle which can only be done by shutting down the crusher. Both crushers of the jaw type here mentioned will produce about the same amount of stone for the same size receiving opening and require about the same horse-power to run. All crushers should be fitted with manganese steel jaw plates, as experience has shown that these plates will last about three times as long as a first-class chilled iron plate, and are unbreakable, whereas the chilled iron plate may break or wear out in pockets after running a very short time.

Most all the crusher manufacturers make complete plants composed of bins, crushers, elevators and engines, which are mounted on wheels and can be loaded upon freight cars without being knocked down. Plants built in this style are very economical to handle and set up and are adapted to nearly all kinds of work requiring crushed stone. Where a traction engine is used for hauling stone away from the crusher, it is more economical to have larger bins and longer elevators than are generally furnished with a strictly portable outfit, as it is necessary to have storage capacity in the bins large enough to load a train of traction cars without waiting for the stone to be crushed. On a good many of these portable outfits, the screen plates and elevator buckets are made of too thin material to wear well, the elevator buckets wearing and rusting away quite rapidly. Unless specially ordered the sprocket wheels and gears are usually made of cast iron. The small sprocket wheels and beveled gears I think should be made of manganese steel.

Crusher Engine

Crusher engines should always be large enough to have a surplus of power over and above that which is ordinarily required to run the crushing plant, and the boiler should have additional capacity large enough to supply steam

for a steam drill, as in a great many cases, if this is not done, an additional boiler will have to be provided. Most of the states have laws which govern the construction and inspection of boilers, and in the states that have no laws now regulating the construction of boilers, the question is being agitated and undoubtedly in a few years there will be such in most of the states, and as road building has become quite an interstate business, and the machinery is transported from one state to another, care should be taken to procure a boiler which will pass state inspection. I believe that any boiler which is built in accordance with the Massachusetts standard can be used in other states, but there are many boilers which can be used in other states which can not be used in Massachusetts. Plants equipped with boilers built to the Massachusetts standard, will cost more than boilers usually furnished with crushing plants. These remarks apply as well to road rollers, or any boilers.

Hauling Engines

Where there is enough work to keep a hauling engine busy and suitable provision can be made for loading and unloading quickly, a hauling engine may be used to advantage, and is about 50 per cent. cheaper than hauling with horses. There is still an opportunity for improvement in hauling engines, especially in regard to gearing and traction wheels, most of the makers using cast steel gears that are uncut and very rough, and which wear very quickly. They also use a built-up riveted or bolted wheel with rolled steel rim. These wheels are generally a source of trouble, as the spokes get loose and break where the traveling is rough and stony, as it is on most construction work.

Road Rollers

There is no class of machinery used in road building in which there is so wide a difference in construction and design and first cost as in the steam rollers. They may be obtained in most any shape or size or design that can be thought of. I think that it is generally conceded by road builders, and it has been my own experience, that a double cylinder steam road roller is better adapted for road construction than any other type. There is no class of road building machinery which has been so highly

developed. The wide variation in first cost of the different steam rollers makes it very difficult for a contractor or town official to make up his mind which one ought to be purchased. There is almost as much difference in road rollers as there is in watches. You may purchase a watch for a dollar which is liable to keep good time for a year, and it is liable not to do so. You may purchase a watch which costs almost any price, and in every case you will probably get just what you pay for. As a general thing, the higher the price up to a certain limit, the more dependable the watch is, and the same rule applies to road rollers. There is no road building machinery sold, that I know of, upon which an exorbitant profit is being made. In looking over a road roller with the view of purchasing, particular attention should be given to an investigation of the gearing and wheels. You can tell by the looks of the wheels and gears upon the machine which has been in use, whether or not that machine is going to do your work day in and day out as it ought to. A set of rear wheels should last under ordinary service, at least ten years. I have wheels which have been in service fourteen years and are good I think for one more. The gearing on steam rollers should be of steel and cut and fitted as nicely as in any high class automobile construction. Gears should be closed so as to exclude dust.

This paper might be extended indefinitely, going through all the different kinds of machinery required for the different kinds of road work, but I am going to conclude, as I have touched upon the equipment that is common to all road construction, whether it be water bound macadam, bituminous macadam or concrete.

CHAIRMAN PARKER: The committee has not selected anybody to continue this discussion or find any fault with Mr. Ellis' statements. I don't know that it is really possible to discuss it. Every contractor has got to determine for himself what his equipment should be, and, therefore, every man might have a different view as to the amount to be expended. If there is anyone who wants to say anything, I should be very glad to recognize him. Otherwise that ends the discussion for today.

Smoker and Entertainment Given Delegates by the Business Men's Club of Cincinnati

On the evening of Wednesday, December 4, the Business Men's Club of Cincinnati entertained the delegates and guests at the convention of the American Road Builders' Association at a smoker and entertainment at the house of the club.

The first part of the evening was devoted to a musical entertainment, during which refreshments were served, and later informal talks were given by convention delegates and by members of the Business Men's Club, some of the talks being illustrated by lantern slides.

The smoker was in charge of the local entertainment and reception committee, of which John L. Shuff was chairman, and was attended by several hundred of the delegates and other guests.

FIFTH SESSION

Thursday Forenoon, December 5

PRESIDENT LEWIS: The session this morning is to be devoted to a discussion of what is in most people's minds when they talk of highways. The first of these papers is entitled "Some Features of Macadam Construction," and will be presented by Mr. T. R. Agg, Road Engineer, Illinois State Highway Commission. I have the pleasure of inintroducing to you Mr. Agg.

SOME FEATURES OF MACADAM CONSTRUCTION

BY T. R. AGG

Road Engineer, Illinois State Highway Commission

Inasmuch as water bound macadam has been written about and discussed so frequently, it would seem that there would be little need to consider it at a time like this. Nevertheless, it is not uncommon to see water bound roads under construction where little attempt is being made to observe the simple and well known principles of such construction, and that is perhaps sufficient reason for some discussion of those principles at this time.

The well known characteristics of a properly constructed water bound macadam road are: A well drained, carefully shaped and thoroughly compacted subgrade; properly shaped side roads and ditches to insure the removal of surface water, and a layer of thoroughly compacted, properly bonded crushed stone, the surface of which has been well keyed together by rolling so that it presents a compact mass of stone of sufficient size to bear the loads that will pass over it without crushing and in which the stones are mechanically locked together by rolling and held in place by means of the dust from the crushed stone which has been worked into the interstices between the stones by means of water and rolling.

In deciding upon the size of the pieces of stone to be used for the upper layer of the water bound macadam road, two things must be taken into consideration—the quality of the stone which is available for use, and the amount of traffic and the weight and character of the loads which will pass over that surface. A road surface carrying a medium or light traffic, of which a small percentage consists of motor-driven vehicles, can obviously be made of smaller sized pieces of stone than a road surface carrying traffic made up of a great many heavily loaded horse-drawn vehicles, together with a large number of motor vehicles.

If the pieces of stone in the surface of the road are so small that the wheels passing over them crush them, it is inevitable that rapid wear will result and that the road will deteriorate quickly. On the other hand, if the surface of the road is made of very large pieces of stone, the traffic will not crush them, nor even wear them with sufficient rapidity to supply fine material to fill the interstices between the stones and keep the voids filled, notwithstanding the action of the elements and traffic. In such a case, the road will become rough and uneven, the surface being made up of rounded stones, which project slightly and make it disagreeable to traffic.

If the road carries any considerable proportion of motor vehicles, the water bound macadam does not prove satisfactory, but a surface made up of fairly large pieces of stone will withstand the action of motor traffic better than one made up of small stones, though the former is less desirable from the standpoint of the user on account of its roughness.

Somewhere between these two extremes, lies the ideal size of stone to use, which is a size sufficiently large to sustain the loads that pass over the road, without breaking, but small enough so that the wear on the surface will furnish sufficient fine material to keep the voids between the stones filled with dust and chips, thereby maintaining a smooth surface.

In the work of the Illinois Highway Commission, it has been found that with the soft limestone available, the size ranging from 2½ ins. to ¾ in., is most satisfactory. When stone of such a size is used it is, of course, desirable to have the surface layer made up of fairly uniform pieces and to keep it free from pockets or patches of the finer material. This can be secured by harrowing the stone thoroughly, after it has been spread, by means of a heavy, stiff-toothed harrow. The harrowing not only brings the larger pieces of stone to the surface, but shakes down any pockets or patches of finer material that may occur.

The stone which is to be used for the wearing course in a water bound macadam, is, as has been mentioned, thoroughly locked together by means of the roller so as to form a closely knit surface. These stones are held in place by means of the mechanical interlocking resulting from rolling and by means of the stone dust and chips which are worked in between the larger pieces of stone by means of water and rolling. Eventually this finer material cements the stone together to form the wearing surface. A great many water bound macadam roads fail to give satisfaction because they were insufficiently rolled, and data collected in the construction of about 125 miles of 8-in. water bound macadam road in Illinois show that on limestone macadam there should be 0.04 of an hour of rolling per sq. yd. of finished macadam.

Most of the rolling should be done before any screenings are spread. If screenings are spread before the stone has been thoroughly rolled, they only serve to separate the larger stones. The resulting surface is made up of individual stones set in pockets of screenings and is not as durable as one made of stones firmly locked together by rolling before any screenings are spread. Moreover, if the screenings are rolled dry much the same result will be obtained. The screenings should be washed into the voids in the layer of stone and be allowed to set before much rolling is done

on them. After the stone layer has received about all the screenings that can be washed into it and these have set for a day or two, the surface should be finished by rolling and sprinkling.

The durability of the surface will be greatly enhanced if it is covered to a depth of about ¾ in. with a good bonding gravel. Such a gravel should range from ¾ in. down, and should contain 75 per cent. of hard pebbles, the remainder being sandy loam. The hard pebbles will gradually work in between the stones of the surface and will add materially to the wearing properties. In addition, advantage will be taken of the tendency for colloidal silicates to form under such conditions, thereby effecting a better bond for the surface than could otherwise be obtained.

Development of the bituminous macadam road has been brought about because the wear of the water bound macadam results in a fine dust which is disagreeable alike to the occupants of vehicles using the road, and to those who live along it, and because roads are being used by an increasing number of motor cars which have the well known effect of blowing away the dust from the road surface and leaving an insufficient amount to fill the interstices between the stone, thereby allowing the stone to become loosened from the surface. Moreover, the thrust of the tire wears the surface rapidly and dislodges any stone not securely bound into the surface.

Inasmuch as the construction of bituminous macadam roads has been brought about to overcome some of the deficiencies of the water bound macadam, it is fair to assume that in the construction of these bituminous macadam roads, all of the good features of the water bound macadam should be retained and these good features be supplemented by the treatment which gives the advantages of the bituminous surface.

The object to be attained in the use of the bituminous surface is to hold the finer material in between the larger stones in the surface of the road so as to prevent loosening of these surface stones and to furnish a coating on the top of the road metal so that the wear on the stones will be reduced to a minimum, thereby eliminating a large part of the dust nuisance. There is nothing in the problem of bituminous construction which would be an argument for

a change in the size of the stone or in the general method followed in water bound macadam construction, provided that the results which are desired from the bituminous surfacing can be obtained without such changes. With these principles in mind, the Illinois Highway Commission has been constructing the bituminous macadam by following, with one or two exceptions, exactly the same methods that would be pursued in building a good water bound macadam road up to the point where the bituminous surface is added.

The foundation of the road is prepared as carefully and in exactly the same manner as for a water bound macadam. The crushed stone is placed on the roadbed in layers of a thickness which will permit it to be thoroughly compacted by means of the roller. Usually the roads have been made 8 ins. thick, 5 ins. of which is in the lower course of stone and 3 ins. in the upper course. It has long been the practice among some engineers to bond the lower course of a water bound macadam road, although the practice is not at all general. In the construction of bituminous macadam roads, however, the practice of bonding the lower course has been adopted. The upper course of stone is placed and rolled exactly as if it were the upper course of a water bound macadam, care being taken to key the stone together thoroughly by rolling so that the amount of voids in the surface will be reduced as low as possible and the stones will be well locked together.

If a road is being built of hard stone, such as trap rock or granite, the upper course might be built of smaller sized pieces than is the practice of the Illinois Highway Commission, which is to use the same size as for water bound macadam. But, in any case, it is not believed that bituminous macadam can be constructed by the penetration method successfully if the upper layer consists of pieces much less than those ranging in size from 1 in. to 1½ ins. If hard materials of this class are used, the screenings may be used in the bituminous construction also; the size ranging from ¾ in. to ½ in. being spread before the first spreading of bituminous compound, and the size ranging from ½ in. to ¼ in., free from dust, being used for the final dressing.

If the screenings obtained from the soft limestones are used in the bituminous construction, there will be so much

dust present even after repeated screenings that the bituminous application will be seriously affected on account of the presence of dust which will prevent the adhesion and penetration of the binder. Moreover, the small particles of limestone possess such a small wearing value that they are practically worthless in building up a durable surface. For that reason, it is better practice to use two sizes of screened gravel in the bituminous construction, one size commonly known as binder gravel ranging from ¾ in. to ⅜ in., washed and carefully screened, and a size known as torpedo gravel, ranging from ⅜ in. to ¼ in., also carefully washed and screened. The gravel used consists of smooth, round or angular particles, very hard and clean.

After the stone for the upper course of the macadam has been rolled, the surface voids are partially filled with the binder gravel, which is whipped into the surface from shovels, and the entire roadway broomed carefully to work the gravel into the voids and remove the excess from the surface of the stone. The surface of the macadam is then treated with an application of about 1 gal. per sq. yd. of bituminous compound, the binder being spread upon the surface of the road with a special pressure spray apparatus designed by the Commission. This apparatus consists of a furnace tank wagon capable of withstanding an internal pressure of 100 lbs. per sq. in., equipped with a manhole for filling and a pipe at the rear for discharging. By means of air pressure on the tank the binder is forced out through a metal hose to an "L" shaped pipe nozzle arranged to discharge directly down on to the road surface. The nozzle is equipped with a steam jet which discharges through the orifice through which the bitumen flows. As a result, the binder is blown out in a fine spray and strikes the road surface with considerable force.

Great importance is placed upon the necessity for applying the binder under pressure so as to insure its being forced down into the voids in the surface of the road. At the same time, the spray blows away all dust or other fine material which would prevent adhesion to the stone. After the surface is covered with the binder, the macadam is rolled once over, with the roller wheels wet to prevent sticking. This rolling is simply to replace any stone that may have been disturbed in the course of applying the binder, and, after rolling, the surface is smooth and even for the subsequent treatment. After this rolling, the sur-

face is sprinkled with the ¾-in. to ½-in. gravel, a small quantity only being used and the gravel being worked into the interstices between the stones with brushes, but a slight excess being used so that the pieces will project slightly above the level of the limestone composing the surface.

This second spreading of gravel is again covered with a bituminous compound at the rate of about ½ to ¾ gal. per sq. yd. of surface, and after it is spread, the surface is immediately covered lightly with the torpedo gravel and rolled. The surface is then gone over with the third spreading of the bituminous binder, the quantity used depending upon the condition of the surface and varying considerably with the size and general quality and characteristics of the gravel used but ordinarily amounting to from ¼ to ½ gal. per sq. yd. of surface. The surface is finally covered with torpedo gravel, rolled and opened to traffic. In the construction of roads in this way a layer of ¼ to ⅜ in. in thickness can be built up on the surface of the stone, this layer consisting of bituminous binder and hard pebbles, making a wearing surface which is of a mastic nature, and contains stone sufficiently hard to withstand a considerable amount of wear.

The action of traffic on such a road is to wedge down the gravel pebbles in between the limestone, forming a crust which is very hard and durable, and at the same time is smooth and affords an excellent foothold for horse-drawn vehicles and a very satisfactory surface for the use of automobile traffic. Usually the most satisfactory texture has been obtained in the surface of the road when the bituminous compound used is of such a nature that it "bleeds" or exudes during hot weather. A road built with such a compound works up into an excellent surface, but some attention must be given to it after the road is opened for traffic, as the "bleeding" will continue for two or three weeks or longer if the weather is hot. This "bleeding," however, causes no inconvenience if the road is kept under observation and covered lightly with gravel from time to time as is necessary.

It is essential in bituminous construction to have access to a laboratory equipped for the examination of bituminous materials if results are to be duplicated, and all materials used should be tested and the results recorded for guidance in future work. Moreover, the construction of bituminous roads requires supervision and workmanship of a high order.

There are many miles of road in the middle western states where of necessity water bound macadam must be built if the roads are to be improved at all in the near future, and there are also many roads that could well be improved with the bituminous macadam and thereby answer all requirements of traffic for many years. Either kind of road must be built with a due regard to a few simple but fundamental and oft-repeated principles which experience has taught are essential to success.

PRESIDENT LEWIS: I am glad, gentlemen, to have the author of this paper confirm what I have ventured to intimate in speaking to you at the opening session—that the day of the water bound macadam has not yet passed by any means. I congratulate you upon having had this subject so clearly and effectively presented.

Before proceeding with the discussion of this topic I want to read you a message just handed me in reply to one sent yesterday.

Tacoma, Wash., Dec. 4, 1912.

Nelson P. Lewis,
American Road Builders' Association,
Cincinnati, Ohio.

"The Washington State Good Roads Association in annual session, returns your cordial greetings and wishes you were here to-night to witness the marvellous views of our great mountain as they are thrown upon canvas and a story narrated therewith by a famous mountain climber."

(Signed) S. A. PERKINS, President.
JOHN S. REA, Secretary.

In order to make it possible for those who wish to do so to leave Cincinnati early enough so that they will reach their homes before Saturday night, the business meeting of the American Road Builders' Associaiton will be held in this room at the close of the afternoon session today, instead of on Friday afternoon, and the Friday afternoon session will be omitted.

Mr. Parker yesterday made an announcement which I wish to repeat. A number of gentlemen here have asked me whether the delegates to the Convention or Congress will receive copies of the proceedings. We cannot, with our exceedingly modest resources, print and distribute gratis copies of the proceedings outside of the membership of the association. The volume this year promises to

be a rather large one. Several papers yet to come will contain valuable data in tabular form which cannot be read but which will be printed in the proceedings. These proceedings are printed for the use of members of the association. Last year we sold copies to non-members at $1 a copy, but we do not know how many to print, and, therefore, can only print a limited number. The book will be well worth a dollar, but it seems to me the best way to get it would be through membership in the association which costs but $2 a year. I cannot but believe that those of you who are here, and who are not yet members of the association would like to have the published proceedings, and the best way to secure them and any other literature put out by the association will be to fill out a membership card covering the year 1913 which will entitle you to a copy of these proceedings.

The discussion of the subject covered by Mr. Agg's paper will be opened by a man whom it is scarcely necessary for me to introduce. Mr. R. A. Meeker, State Highway Engineer of New Jersey.

R. A. MEEKER (State Highway Engineer of New Jersey): Mr. President and Gentlemen of the Convention:—I heartily agree with what Mr. Agg so truthfully said in his able paper—that little attempt is being made to observe the simple and well known principles of macadam construction. While this to a certain extent is true there has arisen a demand for hard roads, and this demand in many cases has been so loud and long that every other quality requisite for a good road has been lost sight of.

It is true that macadam roads are dusty if neglected, but if properly maintained they are no more dusty than many other classes of pavement. Mark what I say—if properly maintained. The great trouble with the majority of road builders and the public at large is that they consider that if a road is once improved, that is the end of it, nothing more is necessary to be done, the road will take care of itself for all time. But the stone wears off, the fine screenings are ground into dust, and the impalpable dust is blown over into the neighboring fields. That is one ground of complaint in New Jersey that possibly is not troubling you people in the middle West. There are farmers and truck raisers who say that this dust depreciates the value of their crops, and particularly that of the smaller fruits. This to them is a serious matter.

If a water bound macadam road is well and properly taken care of and if material that is worn out by traffic is replaced with fresh material and not with dirt, your macadam road will not be objectionably dusty. Many and many a time have we seen a good macadam road covered with mud from the gutters. Of course, our gorge rises to a certain extent; and we get quite an unenviable reputation for kicking; and when they carry that abomination still further and deposit sods and grass upon a stone road words cannot express our feeling. A macadam road in perfect condition should contain not more than 21 per cent. of voids. This is not a guess; it is the result of a number of tests made of the material taken from many macadam roads that have been dug up and carefully analyzed. This density is almost impossible to obtain until after the road has passed through the first winter and spring. Then, if after the frost is out of the ground, the road is well and thoroughly rolled, and all the weak places that develop are strengthened, and the whole surface brought to a regular, uniform grade, the road will wear uniformly and form the best foundation for a future bituminous surface if the growth of traffic warrants the extra cost. This has been proven by years of experience. I would ask you gentlemen who have seen many macadam roads constructed—how manv of them have you seen taken care of in the manner I have described? People seem to forget that the most critical period in the life of a stone road is, like that of a human being, during the first year of its life; and if the road is properly started and gets its proper consolidation the first year, it will last and wear until it is practically worn out. The ruts and dust and raveling of which we hear so much will not appear. Seventy per cent. of the roads in our country are off the through lines of travel. These can still be improved with crushed stone or gravel. If the increased travel causes dust to rise in such quantities that it is objectionable, one or two light applications of a true bitumen will lay it. Possibly I might define a true bitumen as one which contains no lubricating material. If an alleged bitumen contains lubricating material the condition of your road will be like that of the man in scripture out of whom the seven devils were cast.

Mr. Agg's practice of harrowing the stones to secure uniformity in size, while effective for soft limestone, would never do for our harder trap rock and dolomite. We fully agree with his statement that it is necessary to have the surface always made up of fairly uniform pieces and to keep it free from patches of finer material. We find the only way in which we can secure uniform surfaces is by grading the stone carefully before, not after, it is spread upon the subgrade. This method of harrowing is, from an economic standpoint, in some sections, a very good thing. But our experience has taught us that it is almost impossible to properly grade the stone after it is placed upon the road. Therefore we insist that our quarrymen shall supply us stone in regularly graded sizes, and if the stone does not come in those properly graded sizes we refuse to accept it. All of our specifications in the state of New Jersey are drawn in that way. Thus, the contractor who signs the contract to build a road under our specifications makes a contract with the quarryman that he shall furnish him with specification stone. That contract is binding upon the quarryman as well as upon the contractor, and if he does not receive properly sized stone he simply refuses to accept them, and the quarryman does not get any money. Just as soon as a quarryman finds that he is working for love he sees a light and makes up his mind to the fact that it is better to do as he agreed to and not as he wishes to.

All that Mr. Agg said about the necessity of thorough wetting and rolling we most heartily indorse. It is impossible to build a good macadam road without the use of plenty of water. In finishing a macadam road we have found no better rule than that of the master road builder, Edward P. North, who said, "Wet your stone until a wave of mud forms in front of your roller." Miles of macadam road in Central Park for years tested the truth of this maxim. What Mr. Agg said about the wastefulness of rolling screenings dry we indorse. It is a point upon which we are very insistent; in fact, so insistent that our specifications expressly prescribe that no screenings shall be rolled dry. A macadam road, whether it is built of limestone, dolomite, trap rock, or granite, must be treated as concrete and to get good results with your concrete you must puddle it thoroughly. To get good results from

a crushed stone road the surface must be thoroughly puddled until the water comes to the surface. In the earlier days of our practice we were severely criticized for putting too much water on the roads and making the roads and shoulders muddy. Afterwards when the road was finished nothing was said about it.

I notice a great many practical road builders here, and they will all agree with me that if you do a good job you hear nothing about it, but if you make one slip, what you hear is aplenty.

We have listened to many able papers upon the more expensive types of pavement. It has been our endeavor to avoid mention of these as far as possible, confining our remarks to those road coverings that can be most cheaply laid. Each section of the country has material at hand which may be used with great benefit upon its highways. Commissioner MacDonald puts a light coat of stone chips upon his gravel roads and obtains a very good road. We have also used this method with very satisfactory results. If the road builder in each section of the country carefully tests the materials he has at hand, he will find something that if properly applied will greatly improve the surface of his roads—crushed stone in a rocky region, gravel in another, and a mixture of sand and clay in another, till at last we reach the alluvial flats where the paving is done with burnt clay as demonstrated by the Office of Public Roads, and what was alleged to be impossible in road improvement is accomplished.

In New Jersey we have a greater variety of soils and rocks than have many of the other states. Commencing with the older rocks of the northern portion of the state, we run down the scale until we reach the sand and alluvial plains near our southern limits. Therefore our experience is possibly more varied than that of many others. We found that the old assertion that trap rock is the best stone which can be used for a macadam road is subject to qualifications. On heavily traveled roads, trap rock is the ideal stone for water bound macadam. In roads of medium or lighter traffic, we find that a dolomite, or one of the harder limestones, gives far more satisfactory results, is less costly to prepare, and at the same time forms a harder and smoother surface. Hence we must not take the maxims laid down in the books with-

out a grain of salt. You will find possibly, in your own section, material that will improve your highways to a wonderful degree. Proper location, proper grading, proper drainage, and proper construction, will always yield very good results.

We hear a great deal about the waste of money spent in improving roads. It is said: "What is the use, why should we issue bonds for the roads when they wear out in ten years and that which has cost so much will all be gone?" In our state we have built some roads that have cost us $50,000 a mile, but over $40,000 of that was for relocation and grading. Now, that did not wear out. That was not dissipated, but is a valuable asset. When you consider that a 10 per cent. grade requires the expenditure of as much power to traverse one mile of it as would be expended in traveling 6.3 miles on a level, you begin to realize the advantages to be derived from reducing the grades. In the old days they told us that it was a waste of money to grade, and on the old road surfaces this was to a certain extent true, because any load that you could haul through the muck and mud of the flat you could haul up the hard stone hills. Now, those conditions are changed. Upon a uniformly smooth surface it is possible for a team to haul from four to six times as much on the level as it could possibly haul up the same old hills; and if we are to derive the full value from our improved roads proper grading must be given the attention which is its due.

PRESIDENT LEWIS: Gentlemen, this subject is open for discussion from the floor. We will be glad to hear from anyone, and I know that the author of this paper will be glad to answer questions.

F. F. ROGERS (Deputy State Highway Commissioner of Michigan): I would like to ask Mr. Agg about how much he has found the increased cost of bituminous over the plain water bound macadam, also what kind of materials he used this year, and if they have proven satisfactory?

MR. AGG: I will answer your first question and say that the difference in cost between the water bound macadam and bituminous macadam in the Illinois work has been about 18 cts. per sq. yd. Now, as to the repairs, the commission has been conducting experiments on sections

of roads throughout the state upon which they have been using some of practically every bituminous material which is on the market in Illinois; and it would be impossible to go into the results of all those experiments this afternoon. The commission will shortly publish a report in which will be given the results of three years of experimentation with bituminous compounds which have been used with about 20 or 30 different materials. If any of you would care to get that report and will write to the Illinois Highway Commission, Springfield, Illinois, I will be glad to see that you get a copy. In general I would say, however, that we have found that on the roads which are subject to a covering of sticky mud pulling in from the side roads, which is a condition that is found in most of our roads, we found the various kinds of tar binders to be unsatisfactory. On the other hand we have used on some roads which are not subjected to this action, tar binders which have given excellent results. We have also found binders which could be used on a road in a soil of an acid nature, the kind of soil we have in southern Illinois, and the same binder used on roads in the northern part of the state where the soil is alkaline or neutral, went to pieces very shortly. As I have said, we have an extensive series of experiments going through our laboratory, the results of which will be given later.

MR. ROGERS: Just one other question as to the comparative results of hand pouring and pressure spraying?

MR. AGG: We used the hand pouring method for two years, and then followed that by two years of the pressure method. It seems apparent to us that you cannot hope for satisfactory results in bituminous work by the hand pouring method. Occasionally a good road is constructed in that manner, but, in general, in our work we have found that about one road out of four constructed by the hand pouring method has proved satisfactory. This is due to the fact that inevitably the bituminous binder will be thicker in some places than it will be in others. When the road is put under traffic, this conditon is not apparent, but as the road gradually wears, the traffic gradually compacts the surface, then the places where the binder is thick are seen as raised places in the road. The places between these high places being lower, the action of traffic is to increase this effect as time goes on.

Some roads that were constructed by the hand pouring method three years ago had to be entirely resurfaced because the surface became irregular. The texture was all that could have been asked, but it was in this condition due to the effect of the binder put on in that way. We do not think that bituminous macadam can be put down by the hand pouring method. (Applause.)

JOHN S. GILLESPIE (Road Commissioner, Allegheny County (Penn.) Road Department): Mr. Chairman and Gentlemen:—I am taking issue with Mr. Agg and our distinguished chairman in regard to the macadam road. It is something like a prescription. A prescription may cure one when it will not cure another. Macadam roads may be successful in some places, and not in others.

I have charge of the roads of Allegheny County, Penn., and some of you gentlemen have pamphlets showing what Allegheny County has done for good roads. We have at the present time in our county, 450 miles of improved roads. A year ago we had 360 miles of macadam, yet at the present time we have only 308. The reason for this is, up until September, we had about 60 miles of macadam road and we made the same into asphalt roads. Macadam roads are not a success, and have never been since the automobile came into existence. It may not make a difference in the East where Mr. Meeker is—I have been over a great many of his roads—they have the hard trap rock. We, in Allegheny County have the limestone, and most of that is shipped in from Ohio.

I am going to give you the specifications of our roads; and I don't think there is a macadam road built anywhere in the United States that is better built than we are building. Our macadam roads are built with 8 ins. of telford stone, thoroughly rolled and napped, and then we have the macadam top of 4 ins., giving us a 12-in. road. And yet they are not successful.

In regard to the dust, the limestone dust; we have that. We take care of that problem. I am not the father of good roads in Allegheny County, but I have been the mother of good roads for seven years, I have been taking care of them. We do all our own repair work. We have 14 road rollers and we have 14 gangs that are going all the time. Two years ago this summer I had charge of putting on 96,000 tons of stone in resurfacing our

roads. We spend $1,500,000 a year on roads. You will notice by the pamphlet our valuation is high, the same amounting to $1,141,567,110, and there isn't much trouble for us to get money. We have plenty, and we can try anything that we want to that looks good. We have used oil. Five years ago this summer I came down to Cincinnati in company with our county commissioners. We went to Lexington and looked over their oiled roads. Last year we used 422,000 gals. of oil. We have not used less than 300,000 gals. of oil per year for the last five years. Now, I just tell you that to show you that we care for our roads. Not only that, but we have a patrol system in Allegheny County. We always have had it, ever since the first road was built. At the present time we have 110 caretakers. Each caretaker has between 3 and 4 miles of road to take care of. These men are hired by the year; they work every day, and are paid $55 a month. Their duty is to go along and keep the ditches and sewers open, and keep the weeds cut down. As you all know, weeds grow rapidly along a macadam road, especially a limestone road, because limestone is a great fertilizer.

Our experience is that macadam roads are no good. They are a good substitute. As Mr. Agg says, you have to fall back on the macadam. That is all right, but if you have the money you don't want to fall back on macadam. Now, some of you gentlemen have been to Allegheny County and seen our roads, and know that we have built them right, yet they do not stand.

In regard to putting down the macadam road, from practical experience this is what I found: The contractors do not build the roads, or put down macadam roads as we do, because it takes a little more time. I am going to tell you now how we bond our roads so that you will know whether or not we do it right. In putting our roads down we do much the same as the gentleman from Illinois; we put our stone down and thoroughly compact that. I found from experience that by using the larger stones we got the best results. You can go along a road and reach down, blindfolded, and pick up all the stone you can hold in your hand; probably there will be three or four pieces, and by pressing them together they will interlock, and that is why the larger stone is used. That is how the Romans built their roads, with the larger stones and

of a uniform size. We roll that thoroughly, and I have taken 60 bushels of coal across the road just after the rolling and before any screenings were applied, and hardly made any impression on it. We roll the ballast well, and then we put on a slight sprinkling of screenings, and by the roller passing over the same two or three times it shakes the screenings down between the stone. Then we apply the water, thereby getting the road to bond from the bottom. We put on only a light coat of screenings, "feeding" it, as I say to the men, in order to get the proper bond. We then roll the same until we have a batter all over the road. We leave this then, and take the roller on to a new piece of 40 or 50 ft. Too much screenings has a tendency to "choke," giving you the necessary batter, but not the bond.

I might say that I have always found in putting down a macadam road that it is best not to take too long a stretch, because one of the most important points in building a road is the water. If your roller covers too great a distance, you do not get all the benefit of same as by the time the roller goes over the road a second time, the water has soaked into the foundation. I find you have to seesaw quickly to get the advantage of same. You must get the benefit of it before it enters the road.

In starting the new piece, the same methods are applied which I have just given. In a day or two the sun bleaches the road, causing white spots to appear. We then take the roller back and roll the same thoroughly. We then take the roller off and flush the macadam surface well with water, and we leave it. That flushing cements the road tight, and the result is, in a day or two we have a road with a hard, metallic ring. Now, that is the way we put our macadam roads down, so you can be the judges as to whether or not we put the same down right. I condemn it. A macadam road in certain seasons of the year, or certain winters, is better than others. In Allegheny County three years ago this winter, the independent ice companies did not get a single pound of ice. It would freeze a little at night, and thaw out in the morning. I found something new that year.

Seven years ago, when I took charge of the roads in Allegheny County, I was conceited enough to think I knew a little about roads. Things I advocated then, I condemn

now. Then the macadam road was good, but we have a different traffic today. The automobilie has come in and it has come to stay. Even those who say macadam roads are good, find fault and say they can't take care of the automobile.

As I was going to say, where you have an open winter, the frost goes into the macadam, and in leaving the same in the spring it disturbs the bond, making the road "green." During this period you can watch a heavily-loaded wagon go along and rut your road. Now, if you could only close your road in the spring when the frost is coming out, could close it entirely to traffic, the elements would rebond it, but we can't close them and the roads get rutted. Now, gentlemen, that is my experience and my belief is that the macadam road is no good. I don't say they are no good everywhere, but they are no good in our county, nor in the western part of Pennsylvania. We can't get trap rock. A gentlemen here at this convention told me that he could sell us trap rock, f. o. b. the boats at Cleveland for $1.50 to $1.60 per ton. Now, if we are to pay that price at Cleveland, together with the freight to the Pittsburgh district, making a total of $2.25 to $2.50 per ton, it will be cheaper for us to adopt the mechanical mix or penetration. That is what we are doing. This summer we put down 17 miles of penetration and about 30 miles of the mechanical mix.

We have all kinds of roads in Allegheny County, we have the macadam road. brick road, rock asphalt, Warrenite and Amiesite, and we have all kinds of resurfacing work. The telford foundation of the first road constructed in our county is still there, we never lose the foundat'on and the second time a road is covered it is better than the first, even with macadam.

WILL P. BLAIR (Secretary, National Paving Brick Manufacturers' Association): There is just one suggestion that I want to make. It may not reach the point, but the last speaker has just stated that the greatest trouble they have with their macadam roads in Allegheny County is the fact that in the spring of the year and during light winters, where they are having constant freezing and thawing, the road gets into such a condition that it is easily rutted. Now, if the gentleman will permit what may seem to be a criticism of the way in which they build their roads, and

leave their roads in that county, it will be given in the best of spirit, and I believe it may be of some assistance to them, and to all road builders. The condition of a great many roads in Allegheny County is this: The water is not carried from underneath the bed of the road to the ditches on the side of the road. That is the condition of a good many macadam roads in this country in the winter and spring. And that is the trouble with all kinds of roads unless you carry off the water or the moisture and let the air in, not by building a ditch along the side of the road, not by conveying the water from certain stream watering places on the road, where the water oozes out under the road, etc., not by carrying that down the middle of the road and into the side ditches, but by putting in cross tiling at right angles, across the roadbed, and getting that moisture immediately out and keeping your roadbed dry. If you keep your roadbed dry underneath, your moisture, or your temperature—your low temperature—is not going to disturb the aggregates and the condition of the road as found in the summer time. Keep it dry, and it is going to keep in place. That is just a suggestion.

MR. GILLESPIE: Just a minute, please, in answer to Mr. Blair. Gentlemen, I said that the first road built is still as good as ever; and that was built in 1897, showing that it isn't the foundation. We put French drains in every 50 ft. during the construction of our roads. I say that when our roads are resurfaced they are better than when first built. It is not the foundation that gives way, it is the top coat that blows away, the telford remains. The matter of drainage is well taken care of by the frequent use of these French drains.

MR. BLAIR: Oh, but that moisture disturbs the top.

PRESIDENT LEWIS: This resolution has been presented, and will be referred to the Committee on Resolutions:

"The American Good Roads Congress and The American Road Builders' Association in convention assembled declare their unqualified support of the establishment of a system of national highways, and earnestly recommend to the Congress of the United States the enactment of those laws necessary to further the speedy construction of a modern improved national transcontinental highway.

Gentlemen, you will have noticed on the program that

this evening will be reserved for illustrated lectures and talks on construction of various kinds of pavements, and on any road work in general. This will not be one of the formal sessions of the convention, but we are glad to give an opportunity to anyone who wishes to illustrate their methods of construction the chance to do so by moving pictures. I understand that this evening there will be illustrations showing the actual operation of the construction of concrete roads in Wayne County, Michigan, and possibly there will be some other lantern slides shown.

Many of you are from states and counties which are not so fortunate as Allegheny County, Pa., which appears to have plenty of money to spend on roads; counties where the inhabitants per mile of road are not greater than the number of caretakers of the roads in Allegheny County, so that it isn't even a macadam road that comes nearest a great many of you. It is the equally important earth and gravel road in which some of you are most keenly interested. This subject is to be presented to you by the head of the highway department of our neighboring state, Kentucky. I have the pleasure of presenting Mr. Robert C. Terrell, Commissioner of Public Roads of Kentucky.

EARTH AND GRAVEL ROADS

BY ROBERT C. TERRELL

Commissioner of Public Roads of Kentucky

I feel a delicacy in discussing this very important problem of earth and gravel roads. As this class of roads comprises more than ninety per cent. of the total mileage of roads in the United States, and since there are more than 2,150,000 miles of road, you can readily see how important it is to have the earth and gravel road maintained in good condition for travel.

Our President, in assigning me this subject, doubtless overlooked the fact that the Kentucky Highway Department is probably the youngest in the Union and that I, having been honored by Governor McCreary, who appointed me its first Commissioner, feel very keenly the responsibility placed upon me. The work of the department has consumed my entire time, hence I shall have to ask your indulgence for any omissions in the handling of this subject.

Earth and gravel roads—as is the case with most of our roads, it matters not of what material they may be constructed—have two natural enemies—water and politics—and the latter point is not to be overlooked. Water, however, is the subject that attracts the greatest attention in the road maintenance; and, since water and politics do not mix very readily, we will discuss the former.

Thorough drainage is the most important problem that confronts the engineer or road builder. Earth roads must be well drained and properly crowned, in order to be serviceable at all times. The maintenance of a road thus constructed is comparatively easy and not very expensive if the work is done at the proper time, but good drainage is very costly, if not altogether impossible, unless the road is properly located.

A road, in order to be properly drained, must have the proper longitudinal grade; a minimum grade of 0.5 per cent., with a maximum grade of 5.0 per cent., which may be increased, depending upon the amount of traffic and the obstacles met in locating. The minimum grade is necessary in order to give the side ditches the proper amount of fall to carry the water quickly and rapidly along and away from the road. The side ditches should be built of a sufficient width to successfully carry all of the water coming into them, having side slopes of 1½ to 1, or 1½ horizontal to 1 foot vertical, which will prevent the earth from the side caving in either from excessively wet weather, or from freezing and thawing. Side ditches should never be made deep and narrow. If extra drainage is necessary, they should be underdrained by use of tile or by excavating a deep ditch, filling with large stones, or making stone boxes and covering these stones with smaller ones and finally covering with sod, the sod side down, or hay, straw, or shavings from a planing mill, to prevent dirt from washing into the inside drain, leaving a shallow ditch on top. Deep, narrow ditches are dangerous to travel and otherwise objectionable, in that they catch trash and cause clogging, thus forming pools along the side of the road, permitting the water to seep into the foundation of the road and soften it. Where roads are located along sidehills a ditch on the upper side sufficient to take all the water coming down the hill is necessary and if it cannot be constructed immediately along the side of the road, there

should be an additional ditch constructed above the road and parallel to it, intercepting the water from the hill and carrying it along the same general direction with a sufficiently small grade to prevent washing or gullying of the ditch. Where the grade exceeds 5 per cent., the ditch should be paved with stone and the water should be carried under the road from the upper side at short intervals and disposed of without permitting it to collect in sufficient quantities to damage the side of the road or break across it. Under, or subsoil, drainage is frequently necessary where roads are located on low or marshy soil and should be secured by a line of farm drain tile on either side, or by placing the tile immediately under the road. This farm or porous tile placed 34 to 36 ins. deep, and with a grade of ½ to 1 per cent. longitudinally, will keep the foundation of the road free from water, thus leaving the road hard and compact at all times.

Earth and gravel roads should have more care given to their location than roads surfaced with more permanent material, and probably receive less attention. In locating roads attention should be paid to the character of the surface of the soil over which the road is to pass. Clays form very poor surfaces and even among the clay soils there is as much variation of the fitness of the material for forming road surfaces as there is in variation of soils for farming purposes. These poor soils require more careful study and can withstand the effect due to bad location less than any other materials used for road building purposes. However, in many instances the roads have already been located with little or no prospects of change and to relocate a road means, in many instances, the purchase of expensive rights of way, and the changing of routes often causes trouble, because of the improved property along the old right of way.

For the clay soils, roads should be located where the sun has free access to the surface—preferably having a southern or western exposure and having a small amount of shade from trees and shrubbery. Where sandy or gravelly soil is available, it makes a better location for a road than the softer and less durable soils. As a sandy or gravelly soil sheds water very readily, being more porous, permitting the water to seep down and out, it requires less attention for drainage and shade. Sand is better for damp roads.

If the road has been properly located and properly drained, probably the point of most importance is the crown or cross grade. There are several forms of cross section, but the parabola form, in my judgment, is the best, having a center elevation equal to 1-24 of the width of the road. This form permits the more general use of the entire width of the road, as wagons getting across the middle of the road do not slide immediately into the side ditch. However, the parabola form is more costly, as it requires more care in construction. The uniform slope may be used to an advantage on account of the cheapness of constructing the uniform grade by means of the scraping grader, and probably is just as effective. If the uniform slope is used, ½ to 1 in. to the foot will be sufficient, and if traffic is not permitted to concentrate at the center of the road and form ruts, the water will be carried quickly and effectively to the side ditches.

Mud holes have no place in roads well crowned, properly located, and properly ditched, and ordinarily they will not occur. However, the surface will become soft by constant pressure of water from underneath and can only be maintained in good condition for travel by putting in the subsoil or porous tile drains. Other frequent causes of mud holes are the unevenness in the texture of the soil and the combining of vegetable matter with the soil while working the roads; this vegetable matter holds water, thus damaging the surface. In no case should stone be piled into a mud hole, as it only forms a rough and unsatisfactory surface and permits the formation of mud holes at either end from the impact of loaded vehicles dropping from the harder surface of stones to the soil surface beyond. The road, however, can be successfully repaired by the removing of the softer soils, or soils containing vegetable matters and replacing with clay, or soil of the same consistency as the remaining portions of the road, and by removing the shade, so that the sun may have free access to that portion of the road.

An earth road, like all farm land, should have its principal working in the spring of the year when the soils will work most readily and will have time to become consolidated before the fall rains begin. A scraping grader drawn by a traction engine will do excellent work in giving

a road sufficient crown, and the side ditches may also be opened by the use of the scraping grader. The earth removed from side ditches should not be thrown into the center of the road but should be thrown out to the opposite side or left in such condition that it could be easily removed from the surafce of the road entirely and should never be placed where it could be carried back into the ditches by reason of water falling on the surface.

In crowning a road in early spring with a road machine care should be taken that no second or shoulder ditch be left between the center and the edge of the ditch supposed to carry the drainage, as such a ditch only tends to hold water falling on the surface and soften the subgrade rather than offering an opportunity for the water to be carried away. After the road is properly crowned in the early spring, it will need only slight care during the summer and fall months and in most instances this work can be effectively accomplished by the use of the split log drag. A light drag is preferable, which can be easily drawn by two horses.

It is not necessary for me to go into detail with reference to the construction of one of these excellent pieces of road machinery as every one who is interested in road building knows perfectly well the advantages to be gained by the use of a drag.

The amount of road improved by gravel more than equals the amount of road constructed by the use of other materials—probably next to earth roads is the most important—because of the quantity of road surfaced with this material and its low cost and easy method of construction. The same care should be given to the location and drainage as is given to the earth road. In the construction of the gravel road, beginning with the subgrade, it is probably best to open the trench to receive the gravel, giving it the same crown or cross section as the finished roadbed should have, which should be a parabola, with the center height equal to 1-40 of the width of the road. The subgrade should be properly rolled, beginning at the edges and rolling toward the center, as you would the finished road, and where soft places or uneven surfaces appear, they should be filled and shaped and the rolling continued until the surface is entirely smooth. The gravel

should not be dumped in piles as it forms a wave-like appearance after the road becomes thoroughly consolidated, but should be dumped on boards or shoveled out of the wagon and to the roadbed, spreading evenly and in layers of from 4 to 6 ins.

Gravels containing clay or sand, or even loam, not exceeding 20 per cent. of the entire quantity, make excellent road material and will bind or compact very readily. After the gravel has been properly placed on the subgrade it should be thoroughly sprinkled and rolled, the rolling beginning at the edge of the ditch and rolling the shoulder in the same manner as the gravel, so as to have an even surface for the water to shed from the center to the side ditch.

In many instances, however, it is not possible to secure a roller for consolidating the gravel. In that case the gravel can be properly shaped and thrown open to travel, care being taken to fill wheel ruts by moving the loose stones in with a rake until the road has been consolidated to an even surface and having proper cross section. If this care is not given to the gravel when first placed and unrolled, ruts will form on either side by the constant rolling of vehicles in the same tracks and will prevent the water from reaching the side ditches and form channels in which the water will collect and cause much damage.

In western Kentucky our gravel roads cost approximately $1,000 per mile, while in eastern Kentucky, where the country is more hilly and less attention has been paid in the past to the proper maintenance of earth roads, which are being converted into gravel roads, the cost is slightly higher.

In my opinion the maintenance of earth and gravel roads will never be effectively accomplished until we receive government aid for all post-roads and until every road becomes a post-road. I do not mean, however, by "government aid" that the government shall bear the entire or major portion of the expense of constructing or maintaining any road or roads in the Union, but that the government will merely assist in the construction and maintenance of roads to such an extent as will enable the government to direct the local authorities how the work must be done before the federal aid is available,

and then that these roads be put under direct government inspection by making each and every rural mail carrier the inspector of his route, reporting deficiencies in the road as they occur to the local authorities and to make reports to the federal government once each month as to the condition of the road.

R. H. DIXON, Jr. (Roads Engineer, Dorchester County, Maryland): Mr. Chairman and Gentlemen:—I am in a country in which we have an abundance of earth roads and where we are confronted with a proposition which is a most serious one, and I am asking for assistance.

It is on the Eastern Shore of Maryland, and we are nearly as flat there as this floor, and in a great many sections of my county we are only a foot and a half above tide water. Drainage is absolutely essential, as we all know, particularly for dirt roads. My difficulty comes in getting outlet ditches to drain the roads. I put in permanent culverts and proper cross sections, but I cannot get the water away from the roads. The only redress I have is condemnation through the property owners. Where I dig ditches to let the water off some of these roads, which have a grade of only 1 in. in 100 ft., the property owners insist upon driving stakes, or putting wire mesh across the ditches to keep their small stock—pigs, etc.—from coming out into the road. We have considerable pine in my county, and the pine needles and leaves catch in the stakes and completely block the ditches. What I want to ask is this: If any of the gentlemen present have any laws in their respective localities which they think would be of assistance to me and which I might use or have put in effect, which would enable me to get these outlets rather than by condemnation. At present I have to appoint three commissioners. They visit the land, assess the damages, the values, and condemn it. All of you know that this makes a lot of trouble and delay in getting the water away. It is unsatisfactory, particularly because the condemnation committees, nine times out of ten, are in sympathy with the land holders.

Another obstacle with which I am confronted is a road of nine miles, across a marsh. It is now 8 to 10 ft. wide, with ditches on each side into which I can shove a pole 20 ft. The difficulty here is that I can go over this road at

five o'clock one evening, and the next morning at eight o'clock I would find, perhaps, half a hundred holes in this road. The muskrats in the marsh on each side bore up from underneath, and horses frequently get their feet down in these holes. I am up against it on this nine miles of road.

I want to know particularly if any of you in the convention can give me any assistance or any suggestions how to get rid of the road water without condemnation proceedings. I will appreciate the suggestions.

PRESIDENT LEWIS: Is there anybody who can be of assistance to the gentleman from Maryland in his trouble of getting rid of the water and the muskrats?

GEO. W. COOLEY (State Engineer of Minnesota): There are two questions, gentlemen, that the late speaker has asked concerning which I have had some little experience myself.

In the matter of laws to enable one to get rid of water laterally we have found that we have a section in our statutes, Code of 1905, which gives every opportunity to get rid of just that condition. The road overseer or the state commissioner, or any party who is peculiarly interested in the construction and maintenance of a road, can condemn by the usual process and laterally drain from his road to any point of drainage that he chooses by simply having a survey made and appointing commissioners to condemn the land to so acquire it for ditch purposes. We have no trouble at all. In fact, we have never had to condemn. We have sometimes had to threaten to condemn and make the preliminary surveys, and the rest was easy, because they found the ditch would have to be dug across their property, and there was very little objection to it. That is the way we have for draining our land, when we have such conditions, and there is no possible chance to get rid of the water by carrying it along the line of the road. We have done it very successfully, too.

With regard to the muskrats, we have a similar condition existing to the condition in his country. I recall to mind particularly one road about a thousand feet across a marsh, a very nice gravel road, and the muskrats would bore into it from the side, and of course the surface crust would

break up. I would fill that hole, and then they would dig another hole, and so that work of destruction kept going on continually. And they asked me to make a suggestion about it, and I suggested that they get a small boy with a shot gun. I thought that was about as effective a measure as I could suggest at that time, but it didn't seem to be successful. The muskrats got away from the boys. But in driving over a similar road in the western part of our state, I noticed in an old corduroy road built across a marsh that wherever there was a hollow log there was a muskrat, and he would make that hollow log his home. Now, on the suggestion that the muskrats made themselves, I took this piece of road that we had been troubled with so much, and every 50 or 100 ft. I would run in a blind drain about 6 or 7 feet at about the surface of the water—a 6-in. pipe, with a T on the end of it. Then I would close up the ends with flat stones, and the muskrats would invariably go in there and they never troubled the road any more after that. (Applause). I found it extremely successful and very satisfactory, and very cheap.

PRESIDENT LEWIS: I hope the gentleman from Maryland has had some very valuable suggestions.

J. CHARLES DAYTON (County Superintendent of Highways, Cayuga County, N. Y.): Mr. Chairman, the New York state law, of which the gentleman can get a copy in the New York state exhibit, takes care of that matter by providing that the town superintendent shall agree with the owner of the property for damages, if there are to be damages, where it is necessary to go across land, with power of condemnation and all that follows, should he fail to agree. Usually he can agree without any trouble, and it saves a long time of discussion and general ill feeling, because behind the township superintendent is the certainty that he can have it condemned if he desires to do it, and in that way we get our drainage without any trouble.

I only want to say that I envy the gentleman from Pittsburgh who had all the money he wanted for use on his roads.

PRESIDENT LEWIS: This subject—the salient points of gravel and earth roads—leads naturally up to the subject which is next on the program. Trouble from water, and perhaps even from muskrats, can be solved only by

highway bridges and culverts, both of the ordinary type and of the Cooley type. This subject is to be presented to you by a member of our association from whom you have heard before and whom we are exceedingly glad to have with us.

W. A. McLEAN (Chief Engineer of Highways, Province of Ontario, Canada): Mr. President and Gentlemen:—In the southern countries of Europe the peasantry look at the old roads which they cannot account for, and are apt to think that these roads are of divine origin. If they were to come to our continent and go over some of our roads and the structures on them, at different seasons of the year especially, I am not sure where they would think that they had come from, nor would I care to suggest. (Laughter.) There is a tendency I fear on the part of some of the people to suspect that our highways can come from the same source. Now, I am not going to dispute the efficiency of prayer under any circumstances, but I think that the Creator who has given to us the intelligence and the power to put forth the effort expects us to use that intelligence and strength wherever we can do it.

An important part of the highway construction is the building of culverts and bridges, and it is a strikingly interesting part of highway construction. It calls forth the highest technical training that can be drawn upon, and many who build bridges are erecting monuments to themselves that will stand for many years to come. In this I do not speak wholly of the great structures but also of the smaller ones. The small culverts are extremely important on the highway. We have few bridges to construct such as those over the Ohio. Most of us have to come hundreds of miles to see a suspension bridge such as you have here, and for one bridge perhaps of 50 or 100 ft. span there are scores of smaller waterways across the roads. And in the aggregate the cost of the smaller bridge structures may equal the cost of the great bridges. I have prepared a paper to present to you to-day, but, like some others who have preceded me, I will simply try to talk some of the points that I have included in it.

[The paper printed here is that prepared by Mr. McLean. It is used instead of the stenographic report since it, course, presents the subject more fully.]

HIGHWAY BRIDGES AND CULVERTS

By W. A. McLEAN
Chief Engineer of Highways, Province of Ontario

Highway bridges and culverts, in design, methods of construction and supervision, and economic features, form an important and interesting department of highway engineering. Technical skill and training, of a high order are involved, originality and inventive power may be freely drawn upon, and on occasion, the results may be monumental to the designer.

The distinction between a bridge and a culvert is not, in the writer's experience, clearly defined. A bridge is commonly associated with a crossing over a living stream, while a culvert suggests an artificial channel or drain through or under an embankment, length of span and design being distinctive features. The number of bridges of 50 ft. and upwards is usually very limited, as compared with culverts or bridges of 10 ft. or less, which are innumerable. In ordinarily rolling country every mile may have from one to a dozen or more culverts. Bridges are over the few larger streams only, into which the many small water courses converge. While each bridge of 50 ft. span may cost as much as one or two dozen culverts, yet the larger number of culverts to be maintained, makes them, in the aggregate, an important item of expenditure and often much more than a municipality's total outlay for larger structures. Culverts or short bridges are, therefore, from the standpoint of cost, as deserving of careful attention as are the longer structures.

An elemental form of bridge consists of two wooden beams laid across a stream, and supporting a plank floor. To obtain greater strength than simple beams will give, it is necessary to replace them with trusses or an arch. The simplest form of truss is a single triangle, the sides of which are stiff, straight members fastened at each angle, the inherent property of such a shape being that, unlike a figure of four or more sides, it is of rigid and unalterable form. A bridge truss, as ordinarily understood, is a framed structure, made up of a series of triangles so connected as to act as a single body. An arch, instead of a single horizontal beam across a stream, may

be compared to a series of inclined beams so arranged under loading as to convert the bending stresses into compressive stresses.

General Types of Bridges

The general types of steel bridges preferred under the standard specifications of Ontario are:

(1) Rolled beams for spans up to 35 ft.

(2) Riveted low trusses or girders for spans of 35 to 90 ft.

(3) Riveted high trusses for spans of 90 to 250 ft.

(4) Pin-connected or riveted trusses with inclined chords for spans of 200 to 300 ft.

Deck spans are preferred wherever suitable, and Warren and Pratt trusses are favorably considered for spans of 35 to 200 ft., and Petit trusses for bridges over 200 ft. in length.

The foregoing limiting lengths and types are not absolute, but may be varied. The design is in all cases to be such that the stresses in essential members and their connections can be fully determined. Solid concrete abutments, wing walls and piers have practically superseded stone, timber or other substructure for ordinary steel highway bridges.

Concrete superstructures may be classified as follows:

(a) A simple concrete slab with or without steel reinforcement, on solid concrete walls. This style of structure is very useful for spans up to 18 ft., and may have a suitable hand rail of concrete, steel lattice or gas pipe.

(b) A flat concrete top or floor, carried on concrete beams below; the latter, as well as the floor, being reinforced with steel. This type of bridge has been commonly used for spans up to 40 and 50 ft.

(c) Heavy concrete beams on each side (resembling strong hand rails) with a floor system of reinforced cross beams and concrete covering. This type of bridge is suitable for spans of 40 and 50 ft. and is better adapted to a higher headroom than is class (b).

(d) A concrete arch with or without steel reinforcement for spans of any length, but commonly up to 100 or 125 ft. Spandrels may be open or closed. This type of bridge is one of the most beautiful that can be erected for long or short spans. It is economical of material, but

requires a strong and unyielding foundation, as settlement of the abutments is likely to cause failure of the bridge.

(e) Structures other than arches for longer spans than those indicated in classes (a), (b) and (c) may be carried on viaduct posts or bents.

Architectural Treatment of Concrete

The present is notably a bridge building period on this continent. Vast numbers of wooden structures are falling to decay, and are being replaced with concrete, stone and steel—materials which will last for decades, some for centuries. It should be a matter of concern, that these permanent bridges possess architectural merit, such as will, in their appearance, give pleasure to the present users, and which will impress, as we would wish, the generations to follow.

Good architecture has always been a matter of pride to advanced and progressive nations. To this class of construction bridges belong. With splendid cathedrals, public buildings and palatial homes, they have in all ages excited interest and admiration. Many bridges, for their importance, strength and architectural beauty, have been, and are, world famous. A bridge is a prominent part of the highway, subject to special observation from the public. Bridges may in design and construction harmonize with a fine landscape, or may produce discord in a scene of beauty.

Little consideration has been given to the artistic side of bridge construction by municipal authorities having charge of the erection of bridges. It is taken for granted that questions of cost, economy, and utility are of too pressing a character in this comparatively new country to permit any thought of the ornamental. We are learning, however, that scenery and a good appearance in any field, are an asset of value. It is fortunate that good design and good construction possess in themselves, the chief elements of beauty, so that the results have been more harmonious than efforts to that end would themselves produce. Nothing will accord with the ordinary landscape more perfectly than a well built arch of stone masonry, however simple in design. Arches of concrete on the highway are very much of the same class. A well built bridge, composed of stone or concrete abutments

with steel superstructure, may also accord with a landscape without especial consideration having been given to ornamentation. Much could be gained if more attention were paid to the appearance of these structures, but it is very easy to run to the opposite extreme with tawdry results. It is a short step from ornamental construction to constructed ornamentation—the latter a very unsatisfactory substitute for severe simplicity.

Concrete is a material which lends itself to easy manipulation, and much can be done by molding it into graceful outlines. In doing this there should be no attempt at imitating other materials. The imitation of rock-faced stone so often seen in concrete blocks is extremely crude. Fussy ornamentation should be avoided. Concrete lends itself to distinctive and original treatment in the direction of panelings, moldings, and graceful outlines based on proper methods of construction.

Bridge engineers can profitably study architectural design, particularly as instanced by the finer stone and concrete bridges of Europe. Architectural details and proportion are too frequently overlooked. The proportioning of hand rail to the size of bridge should be carefully considered. Coping courses of arches should be sufficiently prominent, and should be slightly arched, otherwise they will appear concave. Wing walls should, if possible, be curved to give a greater appearance of strength. The spacing and placing of spindles, and their design, will add or detract from the merits of the bridge. Wing walls and posts should widen at the entrances to the bridge, as posts or railings standing squarely on the roadway are not ornamental.

Hand rails of short concrete bridges are important. The public driving on the road sees little of the bridge except the rail, and if it is strong and of good appearance, feels assured of the safety and good quality of the entire structure. It is desirable in such short span bridges to extend and slightly curve the wing wall, carrying them to the top of the roadway and putting a hand rail along the full length. For a small additional expenditure an impressive structure can be had, where the results would otherwise be commonplace if not ugly.

The failure of concrete hand rails has often occurred through neglect of temperature stresses. Open rails

should be broken into lengths of 8 or 10 ft., given expansion joints, and the ends of each span supported on a solid post. Between the posts, spindles of various types may be used. The writer has seen a bridge of over 100 ft. length in which much attention was given to appearance, but the hand rails were not given expansion joints, and every concrete spindle in the bridge had been sheared. Concrete railings can be very cheaply made, if designed with ease of workmanship in view, and are vastly superior to the weak and rusting gas pipe rails which disfigure so many concrete bridges.

A common fault in short span country bridges and culverts is that they are too short, with insufficient width of roadway. As a rule it will be found as cheap to carry tile entirely across the road, using lower head walls and widening the fill, as to use a shorter length of tile with necessarily higher and longer head walls to retain the earth fill. The clear width of roadway for short span bridges on country roads should ordinarily be at least 20 ft., as narrower roadways have an element of danger, and, in appearance, are an obstruction rather than a continuation of the roadway.

Surface treatment of concrete is important. The surface should be a part of the concrete itself. A mere plastering of a defective surface will not permanently remedy the defect. In securing a good finish, the form work should be dressed and closely fitted. The concrete mixture should be wet; should contain sufficient sand and should be carefully spaded against the forms, so as to avoid air holes or cavities. A good finish can be obtained by using fine granite in the surface mixture, this to be treated with acid or brushed with wire before the concrete has fully set. This treatment is not practicable except for special work, but in all cases a smooth and close grained surface can be obtained by using sufficient care. The practice of making the exposed surface of stronger concrete is good, and is readily accomplished by carrying up a board a few inches inside the surface to retain the core concrete until it is partially set, when the board can be removed and the surface concrete put in place. The marking or molding of concrete to imitate stone or other material is never a success. Concrete is a strong and durable material, capable of good treatment, and should frankly stand on its honest merits.

Life of Bridges

A covered timber bridge with heavy oak stringers, erected at Napanee, Ontario, in 1840, was replaced by a steel structure in 1910, after a life of 70 years. Many wooden bridges with covered trusses, have been in use for 25 years. The ordinary wooden truss bridge or culvert as now built, rarely lasts more than 10 years. Lumber now obtainable is inferior, the price constantly advancing, and workmanship is less reliable. Repairs are needed every year, and the cost of these, in sending men and material for necessary details of maintenance, such as putting in a new stringer, plank or post, very soon runs up a bill equal to the original cost of the bridge.

On old turnpikes built in stagecoaching days, the remains of many very fine stone arches are to be found, but in the neglect which accompanied the era of steam railway building, these old structures, without pointing, have in many cases fallen to ruin. Within the writer's experience, wooden bridges and stone arches are, with minor exception, giving place to steel and concrete, and modern bridge building involves almost wholly a consideration of the latter materials.

Structural steel as now used is practically a new material It is little more than ten years since it has wholly superseded wrought iron. No structural steel highway bridges have been erected long enough to fully determine their life. In any event, their life is dependent upon the quality of the bridge and careful maintenance. Light or otherwise inferior structures, put up by incompetent makers, have failed within a year, or have required stiffening and strengthening.

While the life of steel bridges has not been fully indicated by experience, yet present knowledge would suggest that, for ordinary highway service, with proper strength of construction and subsequent attention, they may be expected to last for from 40 to 50 years. Under railway traffic the life is short as the strain is greater, and the corrosive effect of coal smoke is very destructive. Steel bridges require attention to maintenance in the matter of painting, tightening and putting in new rivets, but this can be done periodically, and in a comprehensive manner, so that the cost of repair is not made up of time wasted in going to and from the work with men and

material for trifling defects, as with timber. By using steel stringers, concrete floors, and concrete abutments, a large measure of durability is attained.

The ordinary life of a concrete bridge is as yet not known. Much will depend on the design and workmanship. Many poorly designed structures may have to be replaced after very limited service; but granted good design and workmanship, it is difficult to see why a bridge of that material should not endure for centuries, nor is there reason to doubt the great durability of steel reinforcement, provided the steel is properly protected, and the designer has not placed too great reliance upon it in caring for tensile stress.

Traffic and Loading

The traffic which bridges are required to carry has been greatly increased in recent years, and still heavier loading may be anticipated. Traction engines of 6 or 8 tons with threshing outfits are the greatest concentrated load which many bridges now carry, but with the improvement of roads, and concurrent growth of motor traction, rural highways, especially those carrying interurban traffic, must be designed for heavier loads. A motor truck itself weighing 6 tons, is capable of carrying an equal load or 12 tons in all, two-thirds of which is concentrated on the rear axles. Each wheel thus carries 4 tons, a load which floor systems should be designed to support. In England interurban traffic shows instances of steam trucks with loads aggregating 40 tons in weight.

Shop Inspection of Steel

Shop inspection is important for all steel bridges. The engineer employed by a municipality could rarely do this personally but can employ an inspection company. Inspection companies make a specialty of this work and the charge is usually small, about 50 cts. per ton of steel.

When steel reaches a bridge company's works from the rolling mills, it is usually piled in an open stock yard where, for the period of storage, it is exposed to the weather. When required for a bridge it is taken into the shop, and the first operation should be to run the plates and flats through horizontal rollers to straighten them. Wooden or cardboard templets, previously prepared in the templet department, are then laid on the steel, and rivet

holes and other dimensions are marked off, after which the steel is taken to the shear-coping machine or punches. The steel should be again straightened if necessary to remove distortion created in punching or shearing, and contact surfaces given a coat of paint. Angles and plates are then assembled to form the various members, placed on the riveting horses or skids, and riveted together. The members, as completed, are given to the painters, to receive a shop coat of paint. When it is specified that field connections are to be shop assembled and reamed, the truss is laid out flat, each member in proper position, the required camber is produced by opening or closing splice joints of the bottom chord, and the field connections are then reamed out. The several members are then matched-marked for field erection, and are ready for shipment.

Throughout this process are many points for which careful shop inspection should be provided. Some bridge companies paint their stock as soon as received from the rolling mills, while others do not. Material which has been in stock for a considerabe period and, unprotected, has become pitted and corroded, should be rejected. It should be seen that material is properly straightened when taken from the stock yard for fabrication, a rolling operation which is omitted in some bridge shops. Templets should be checked over to see that they are correct and according to the plans. They should be made to lie flat on the steel, and without distortion, when the steel is being marked for punching and cutting. In punching rivet holes, special supervision should be given to the punches and dies, to see that they are such as will produce a sharply punched hole, with almost parallel sides, and within the specified clearance. For work of the best class, rivet holes should be punched smaller than necessary, and reamed to the required diameter. If this work is left until the members are assembled, the reaming, in addition to removing the crystallized steel caused by punching, will correct slight inaccuracies making rivet holes coincide, and permitting a much higher quality of riveting. Workmen dislike to handle steel newly painted, and are apt to neglect the painting of contact surfaces before assembling. Size and shape of rivet heads are largely dependent on the condition of the dies and the latter should be carefully watched; sufficient force should be provided in the case of

pneumatic riveters to properly enlarge the shank and produce a full, round head. All rivets should be tapped to see that they are tight, and it should be seen that they are in proper alignment. With good riveting equipment, the percentage of bad rivets is very small, but with hand driven rivets, it may be as great as 15 per cent.; all of which should be removed by order of the inspector.

After riveting, it must be seen that a proper quality of paint is used, not merely a coloring material; and that defects such as open joints, cracks, mis-punched holes and rolling mill defects are not covered up by paint, paste and putty. To bring top chord and compression joints into close contact, they should be faced exactly, and at right angles to the axes of the members, by means of rotary planer. All these are details which large bridge shops are apt to neglect if proper shop inspection is not provided, or for which the smaller shops may not be equipped.

Field Inspection of Steel Bridges

Field inspection under the engineer should commence with the transportation of the material from the railway to the site of the bridge. Care should be taken to see that the steel is not carelessly handled or piled so as to cause distortion. Long members should not be allowed to project so far behind the wagon as to become bent, and material should not be dumped roughly from the wagon; nor should the steel be allowed to become covered with mud, as there may or may not be difficulty in having it cleaned off before painting. Any material damaged in transit should be rejected when such damage consists of sharp kinks. Slow bends only should be rectified in the field, and in no case should a member be heated for this purpose. The straightening of a built member should not be permitted after the parts have been riveted together.

Falsework should be strong and rigid, and the camber blocking carefully adjusted; without which the several parts will not assemble accurately and drifting, with distortion of rivet holes will be necessary. Proper alignment of trusses, close contact of compression joints, tightening of tension members, clearance at the expansion end of the bridge, full bearings for steel joists and truss shoe-plates are important details to enforce. The inspection of field riveting is exceedingly necessary. Hand-driven rivets can

be made as tight and as well formed as shop rivets, but this has usually to be urgently insisted on by the engineer.

Bridge Flooring

Plank floors on steel bridges commonly wear out in from two to four years, and are a constant matter of expense for repair and renewal. The tendency for bridges under the writer's control, is to use concrete flooring. The latter material, however, is heavy, adds a considerable dead load to the bridge, and largely increases the weight of steel required in the trusses. A problem for frequent consideration by the engineer arises in determining for a given site the relative economy of a light steel bridge with wooden floor or a heavier bridge carrying a concrete floor.

Where traffic is infrequent, and loads will not exceed six or eight tons; where future increase of traffic is improbable, the lighter structure with wooden flooring may give the better service. Where loads approaching that of a 10-ton roller will be carried, or where motor truck travel may be anticipated, wooden flooring is not strong enough for the concentrated load, and better results are had from a concrete floor system. For short spans the difference in expenditure is not great, but for spans of great length, careful analysis of cost should be made.

The solid concrete floor has advantages, in addition to a more durable wearing surface, particularly the extent to which it distributes the concentrated load. With a plank floor, the weight of every vehicle passing over it is transmitted to the individual members of the bridge, causing a constant jarring and distortion that is very destructive to the joints and connections. With concrete, on the other hand, the weight of a passing vehicle is spread over a greater area of the bridge structure, the floor being a monolith and distributing the concentrated load over a much greater bearing than can each plank. In this way the injury to the bridge is much less with a concrete than with a plank floor.

So much is this the case that with a concrete floor it is not necessary to restrict the speed of vehicles traveling over it. With a plank floor it is always expected that horses will not be driven over the bridge faster than a walk, but with concrete floors, travel is not interfered with, and horses may be driven at any pace.

Painting Steel Bridges

Rust is the chief destructive agency of steel highway bridges. Railway bridges are greatly injured by the vibration caused by heavy moving loads. Frequent and thorough cleaning and painting are necessary to the preservation of steel highway bridges. If they could be fully protected from rust, steel highway bridges would last practically forever. It is found that painting is required about once in five years—oftener if the bridge is in a much exposed situation by the lake shore or seacoast.

Before painting steel, the surface should be absolutely free from rust, scale, moisture and grease. Rust is removed by scraping with steel scrapers, and scale, by the use of stiff wire brushes, or more effectively by use of the sand-blast. Rust left beneath the paint will spread, in time the paint will flake off, and the metal is then wholly exposed to the destroying action of air and moisture. As portions of the metal in a bridge are only ¼ and 5-16 in. thick, it is evident that rust, acting on both sides, can greatly weaken the structure. Connections, too, require special care, to see that they are fully protected. Bridge companies rarely exercise sufficient care, when erecting a bridge, to see that the scale is fully removed and the bridge properly painted.

The materials commonly used in painting bridges are red lead or red oxide mixed with linseed oil. All are subject to much adulteration and care has to be exercised to procure reliable materials. Lampblack added to red lead, will change the color to a rich chocolate, and will not injure the paint. The standard specifications of Ontario provide that, while other materials subject to approval and test may be used, the paint used shall consist of red lead, lampblack, and pure raw linseed oil. The shop coat shall contain 12 lbs. of red lead, 8 ozs. of lampblack, and 1 gal. of linseed oil; the first field coat to be 15 lbs. of red lead, 10 ozs. of lampblack and 1 gal. of linseed oil; and the final coat to be 15 lbs. of red lead, 13 ozs. of lampblack and 1 gal. of linseed oil. Each coat is to be thoroughly dry before the next is applied. The red lead and lampblack shall first be mixed dry, the linseed oil added, and the mixture stirred to a uniform consistency, and maintained at such consistency by frequent stirring during

application. Only a sufficient quantity for immediate use shall be mixed at once. Thinning and drying ingredients will not be allowed.

Circular Culverts

Culverts up to 3 ft. in diameter are now being commonly made of concrete tile. When properly made and laid, they are very durable and, where suitable material is available, of low cost. Where material for concrete is not convenient, corrugated iron culverts are very often well adapted to certain situations.

It is especially necessary that concrete pipes be strongly made, with the materials well mixed, the cement of a good quality, the thickness of concrete ample and proportioned to the diameter, a sufficient covering of earth when laid, and the size of tile large enough for the flow of water.

These culverts should not be made too short, especially at road intersections. It does not cost very much more to make the length ample for the safety of the public, preferably the full width of the road allowance.

If good results are to be obtained from the use of concrete tile culverts, the tile must be put in place with reasonable care. It is, in the first place, necessary that they be laid with a good fall on a regular grade to a free outlet, in such a way that water will not stand in them. The tile should be laid with the spigot end down grade, and the joints made tight with cement mortar. If the joints are open, water is likely to work along the outside of the culvert, and finally make a considerable channel, which will allow the culvert to get out of line and finally result in a "cave-in." To prevent the water finding its way along the outside of the pipe, the ends should be protected with concrete or stone head walls.

A concave bed should be excavated for the pipe to rest in, thus securing an even bearing, without which a heavy load passing over before the culvert has properly settled into place may burst the tile. Tile cannot be used for very shallow culverts, but must have a sufficient depth of earth covering to protect them from the direct pressure of heavy loads. At least 1 ft. of earth over the top is advisable in every case, but for culverts of 2 ft. in diameter or over, this should be increased to 18 ins.

The earth should be well packed and rammed around

the tile to secure a firm bearing, and light soils should not be used immediately over or around the culvert. A heavy clay, a firm gravel, or a compact sand will answer, but vegetable mould, fine sand and light loams are subject to washouts.

At the outlet, the culvert should be set nearly flush with the surface of the ground. If set higher than the surface, the fall of water will wash out a depression, and in time will undermine the end of the culvert. A too rapid grade will have the same effect, and it is well to cobble pave an outlet where this undermining action is likely to occur. The diameter should be sufficient to carry the maximum flow likely to occur in a term of years, otherwise a washout will sooner or later result.

Concrete Construction

Concrete construction (while progress may be made in the future) has passed into stages of standard methods, and is no longer experimental in so far as assured results are concerned. Past discussion has centered around the relative values of broken stone and gravel; wet and dry mixtures; methods of mixing, types of reinforcement and other details which belong to general practice and need not be considered in this paper.

Whatever specification is determined upon, however, it should be carried out with intelligence and in good faith. To this end, capable inspectors are necessary. Carefully drawn plans and specifications are of little value if their interpretation is left to men who have no proper knowledge of the properties of Portland cement and its use. Inspectors should be selected by the engineer, and should be carefully instructed before being placed on the work. Inspectors appointed by boards of works because of their political or other allegiance can rarely be expected to develop the skill, interest and enthusiasm that properly belong to the position, and which are essential to best results. The writer has in the past found young engineering students of the second or third year to be in many respects well qualified, while the experience and training is of much value to them and ultimately to the public.

Better results could in many cases be had, were engineers to give more attention to form work. Too frequently this is left to the rule of thumb methods of the

foreman or contractor; whereas it is of vital importance that forms of adequate strength and of exact dimensions be provided if the strength and beauty of the structure are not to be jeopardized. Economy and perfect results will be greatly facilitated by detailed drawings for well designed centers and forms.

Provision for Cost

The repair and renewal of small bridges and culverts, during the timber or plank period of construction, has in purely agricultural districts, been a serious drain on municipal resources, but the policy now being adopted cf replacing these with concrete or other permanent material is one which, in the near future, promises to relieve taxpayers of this annual expenditure, and permit the outlay to be directed to more necessary road building.

Some municipalities, with commendable desire to avoid public debt, are burdening themselves and delaying progress, in order that all bridges and culverts may be built by annual levy. Where permanent material is used, construction carried on under proper supervision, and repairs provided for, there is every justification for borrowing money to build bridges of steel or concrete, extending payment over a term of 20 or 30 years. In this way those who benefit hereafter will contribute to the cost, and those who use them today are not unduly burdened.

This does not apply (it must be emphasized) to flimsy steel trusses, weak concrete structures, wooden floors and substructures of steel legs, steel tubes and wooden backing; but only to those in which the greatest degree of permanence and strength is provided with a view to future traffic demands. The future should not be burdened with charges for which they derive no service.

Road building has, in the past, suffered much by this annual demand for culverts and bridges. A decayed bridge, or broken culvert must of necessity be replaced or repaired, while the road, if at all safe or passable for a part of the year, can wait. It should not be forgotten that, while bridges are necessary, they are only a short part of the highway; are only built because of the highway, and are an unfortunate necessity. Users of the road may pass over a bridge or culvert in ten seconds, while it may take ten minutes or longer to drive over a mile

of road. The writer has found many localities in which excellent bridges are being built, but in which the roads proper are in a neglected state. Good bridges should be accompanied by good roads, and every councilor may feel assured that the community which will sanction expenditure for permanent bridges, will, with equal good will, sanction the cost of good roads when shown a model of what well directed expenditure will do in that regard.

The Purchase of Bridges

The purchase of a steel bridge may be made through an engineer or engineering department; or as is commonly the case, a municipal council or bridge commission carries on negotiations without the services of a qualified engineer.

In the latter case, a common practice is for the council or commission to determine the span of the bridge, and advertise for tenders, stating, perhaps, that the bridge is to comply with certain general specifications, or is to be strong enough to carry a stated load. Representatives of the bridge companies interview the members of the council or the commissioner, tenders with or without strain sheets are received, at the appointed time are opened, and the contract is awarded often on the basis of lowest tender alone. Under such practice the writer has known a difference of $5 in the tender to cause a council to authorize a contract for a bridge of $500 less value, with no guarantee that the bridge would be built even as the tender specified. The services of a competent engineer, costing from 5 to 7 per cent. of the price of the bridge, would have doubled the life of the structure and given a much greater assurance of safety to the public.

Councilors cannot be expected to judge as to the qualities of a steel bridge, as they can of timber, with which they are all familiar. For steel and concrete bridges they are fully justified in obtaining proper engineering advice—or rather, a council is not justified in doing otherwise. Steel bridge design requires a mathematical training such as only engineers possess.

An engineer's services in the erection of steel bridges will usually consist of:

(1) The examination and measurement of the site of the bridge, changing the location if advisable, determining the number of spans, material and type of bridge.

(2) Preparation of plans and specifications and taking tenders on a uniform basis for abutments and piers.

(3) The preparation of specifications for the steel superstructure, with such plans as may be required.

(4) Preparation of notice or advertisement calling for tenders for steel superstructure, so arranged that all companies will tender on a uniform basis.

(5) Scrutiny of the plans and tenders submitted by the bridge companies, and advising council as to the most satisfactory.

(6) Such inspection of the bridge during construction as its size and importance may render advisable, and arrangement for shop inspection.

(7) The inspection and final acceptance of the bridge upon completion.

Forms of tender and specifications should always be carefully drawn so that every contractor or company will tender on a uniform basis; and parties tendering should know that construction will be under an engineer who will see that inspection throughout will be careful and complete, and that all details of the agreement are complied with. The engineer may prepare detailed drawings of the steel, or may accept those submitted by a bridge company. Either practice is satisfactory if the specifications respecting design are well arranged and the engineer checks the plans thoroughly to see that the specifications are complied with by the plans of the successful bidder. To meet this condition, the Provincial Highway Department of Ontario has prepared general specifications for highway bridges which fix standards for the province.

The writer has no wish to speak slightingly or unfairly of the well intended efforts of many councilors to be economical and keep down municipal expenditure. They have been in the habit of themselves designing and building wooden bridges, and both they and the public have to discover for themselves that, in handling steel and concrete, they are entering a new field requiring specialized training and experience, and that a wider economy dictates the employment of engineers for this work. They may have at some time employed a local or other engineer with discouraging results. Engineers in many localities have, in the past, found so little demand for their services in this regard that they may not, in all cases, have kept

prepared for this branch of professional work. Even engineers require experience; but given experience, they are able to apply it to better advantage than is the layman. When municipal councils and the general public learn, as they are steadily doing, the advantages of specialized services in bridge construction, the engineering profession as represented by local practitioners will respond to the opportunity.

State Influence

At the inception of the work of the Highways Department of Ontario, it became evident that municipal councils and the public needed education in relation to bridge building. Bridges and culverts to that time had been very commonly built of timber, iron and stone, but steel trusses, concrete abutments and concrete arches were coming into use. Plank culverts had been built without plans under the direction of pathmasters, and wooden bridges were being erected by local carpenters and builders. A prejudice existed against the employment of an engineer in any capacity, and the public and municipal councilors were slow to recognize that steel and concrete were materials demanding technical training as well as practical experience.

To meet this situation the Highways Office prepared plans and specifications upon request, free of charge, in so far as the staff limitations would permit. This assistance encouraged many councils to commence a permanent type of construction where timber would otherwise have been used; and the public was given practical models of durable structures. With this instruction, the Highways Office was enabled to impress the fact that for the successful use of steel and concrete on any but the smallest scale, the services of a trained engineer were necessary, not only to prepare plans and specifications, but to superintend the letting of contracts and erection.

Criticism on the part of engineers was at once offered. The giving of plans, free of charge by the Provincial Office, it was argued, was trespassing on the rightful domain of private practice. The Highways Office was able to reply that the same objection had previously been raised to similar procedure respecting road and street construction, but that the net result had been to largely increase

the demand for engineering services in paving and road work, and that a similar result was anticipated in the matter of bridge building.

Later experience has fully justified this policy, and in bridge building as in road construction, civil engineers are being much more largely employed, for councils and the public are learning that even standard plans for short spans need the skill of an engineer to adapt them to each situation, and to guide their erection under either contractors or foremen. The municipal code now requires that all county bridges shall be designed and built in accordance with the general specifications of the Chief Engineer of Highways for the Province, to whom plans for important structures are also submitted. Without the efforts of the Highways Office in preparing plans as an educational work, the existing requirements of the Municipal Act would have been impossible. The ideal condition has not yet been reached, and inferior bridges are still being erected, but the educational effect of good design and supervision, assisted by failures and washouts where these are lacking, is steadily having a beneficial influence. Greatly improved bridge construction has been effected, the public is more and more recognizing the necessity for engineering services, and the members of the engineering profession of the province are, and have every reason to be gratified, as the demand for their services in this regard has been greatly extended. Reputable bridge building companies are in sympathy with the movement, as the basis of design is fixed, and they are not compelled to erect flimsy structures in competition with other companies willing to carry on that class of business.

From experience in the Province of Ontario the writer is of the opinion that state and federal highway departments can exercise a most beneficial influence on highway bridge construction, to the manifest advantage of the ratepayers who pay for the work, the traveling public whose safety and convenience are at stake, bridge companies and contractors who desire to erect creditable structures, and the engineering profession whose services in this regard are as yet but scantily appreciated.

To this end, an educative policy should be followed, necessarily implying more or less gratuitous services on the part of highway departments. Compulsory approval

of plans and specifications by the state highway department is also a measure which may be exercised with good results.

PRESIDENT LEWIS: I am glad that the author of this paper has shown you that the highway culvert and bridge is something more than an ordinary structure. It should add dignity to our highways and render them attractive. I am glad also that he touched upon the question which has bothered the minds of some of our engineers during the last year or two as to the propriety of a state or federal government providing designs and specifications for such structures. The discussion will be introduced by Mr. A. W. Dean, Chief Engineer of the Massachusetts Highway Commission.

A. W. DEAN (Chief Engineer, Massachusetts Highway Commission): Mr. President and Gentlemen:—It was my pleasure and privilege this morning to read this paper which has been prepared by Mr. McLean; and knowing that I was to open the discussion on it, I naturally had a mental tendency to read the paper searching for something to adversely criticise. But I will admit I was disappointed. There were a few points, however, in the paper, that I did not think he covered quite as completely as he should, and one or two little points that I think should be repeated in order to give a little more weight to them.

The first thing I noticed was in his statement that concrete was almost wholly taking the place of stone and wood in the abutments and piers of modern bridges. That may be true of bridges in certain climates and in perhaps a large portion of the country. It cannot be true, however, of bridges over salt water, subject to the rise and fall of the tides. We have found in Massachusetts—and I think it has been found everywhere where they have sufficient cold weather to freeze salt water—that between the high water mark and the low water mark the concrete does not stand. Whether it is due to freezing or what is the exact cause of this deterioration of concrete between high and low water marks I have never heard positively stated. It is true, however, that there is nothing that will stand like stone on the portions of the abutments and piers between the high water and low water marks.

Another point that I noticed in his paper was that he

speaks of substituting concrete slabs for wooden floors on bridges. There is no question but that it is economical on new bridges that are designed for concrete floors. But I have seen in my experience two or three cases where a superintendent of streets had heard about putting concrete slabs on steel beams, thereby making an absolutely permanent floor as he understood it, and tried the experiment on the next bridge that required planking. Of course, the result was he increased the load of his bridge by about 100 lbs. per sq. ft., and the bridge was strong enough to hold up the slabs but was overloaded when a team passed over. In several instances where we have had steel bridges with wooden floors we have prolonged the life of the floors of these bridges by almost 100 per cent. by treating the floor of the bridge just exactly as we treat the surface of our macadam roads in a great many cases, that is, spreading on perhaps ½ gal. per sq. yd. of tar of not too great viscosity and covering that with grit. This not only protects the floors from the wear of horses' shoes, but also preserves the floor, the oil in the tar preserving the floor boards to quite an extent.

Another thing which I would like to commend is that in the construction of concrete bridges we do not try to imitate a stone structure with this material. A concrete bridge can be made just as beautiful as any stone bridge, by proper manipulation, and it costs very little more to make an architecturally beautiful bridge with concrete than it does to make an ordinary bridge with every face smooth. But if attempt is made to imitate a coursed granite bridge with concrete, it certainly is very offensive to anyone who has an eye for beauty. It is like purchasing stained pine and pretending that you have real mahogany. Concrete is just as good looking as granite, if, as I say, it is properly handled.

One point that I have noticed very frequently, and which Mr. McLean spoke of, is the tendency to construct short culverts, making the roadway perhaps 16 ft. wide over the culverts, all other parts of the roadway being from 21 to 25 ft. wide, it being possible that the person putting in the short culvert is trying to save a little expense. Now, a 2-ft. culvert made out of cast iron pipe can be built 21 ft. long under ordinary circumstances just as cheaply as it can be built 16 ft. long. It takes for an ordinary culvert head

about 2 cu. yds. of concrete. Suppose the concrete costs you $8 per yd., which is pretty low for small jobs of that kind, the culvert's ends cost you $16. If you attempt to shorten up your culvert you have got to build each culvert head just about twice as big in order to take care of the slopes. There is $16 additional cost of culvert head, which can be used in the construction of a wider culvert, and you have then a good roadway without having your culvert noticeable and at no greater expense than when you attempted to be falsely economical. I thank you gentlemen for your kind attention. (Applause.)

PRESIDENT LEWIS: Gentlemen, this subject is open for discussion from the floor.

L. R. GRABILL (Superintendent of County Roads, District of Columbia): I just want to ask the speaker one question. I want to know a little more about the details of covering an old plank floor with a bituminous coating. It has been by experience, very often, with an improved roadway, that the worst place in the roadway was the wooden floor of a bridge. The wooden floor will not last under traffic near a city over two or three years. New floors are quite expensive, and the bridge department won't let us add other things that increase the weight on the structure. Now, I have had a talk with our bridge engineer as to some schemes for smoothing up the flooring on some of our old wooden bridges without necessarily laying a new floor. The flooring is strong enough, but it is rough, and when you get on it with an automobile you might as well be riding up a ladder. If there is any scheme by which that flooring can be smoothed up, it will take out some of the worst places in some of my roads, and I would like to ask for some detail as to that covering: (1) whether there is any difficulty arising from the bitumen softening up and going through the cracks of the floor; (2) whether it becomes rough; (3) whether it becomes hard. If you can overcome those, I think another question would be as to whether it does not tend, by covering the floor, to prevent the access of air; and whether or not it tends to rot the floor to some extent and become an unknown seat of weakness. This is the question raised by our bridge department, and if there is any information on that subject I would like to have it.

MR. DEAN: The flooring of a bridge that is worn is

quite rough, and you won't make it perfectly smooth by this tar application. You will, however, have greatly improved the condition. If there are little depressions in the floor, the tar, before you get it covered will run into those depressions slightly so that there will be more tar in the depressions than there is on the elevations. Consequently more grit or sand, or whatever you use, will be taken up by the tar, thereby making it more smooth. It will not make it any more rough than the bare plank, and you still have the advantage of the decrease of wear on that plank and the preservative action of the oil in the tar. Of course, the tar covers over the top of your plank so that you won't see a defect in the defective plank if you once cover it.

PRESIDENT LEWIS: I am sorry we haven't any more time at our disposal.

I would like to announce the result of the ballot taken yesterday. The 125 ballots which were cast indicate that your choice of topics for discussion at tomorrow's session was as follows: 1st choice, "Convict Labor on Roads; second choice, "Division of Expense of Road Improvement over Town or Similar Local Unit, County, State and Nation"; third choice, "Correction of Alignment and Grade in Existing Highways." These, gentlemen, are your choices. We want it distinctly understood that this is to be your session. The plan is to assign three-quarters of an hour to each of these discussions, to have the discussion opened by an address not exceeding ten minutes in length, to be followed by a general discussion, each speaker being limited to five minutes. Subject to your approval, those rules will govern the discussion tomorrow morning.

SIXTH SESSION

Thursday Afternoon, December 5

PRESIDENT LEWIS: It has been the policy of this association to confine its formal papers and discussions to problems of road building and maintenance, and we have always consistently excluded any paper which was in the slightest degree commercial in character. I have been asked several times since I arrived in Cincinnati whether the association was departing from that policy. I have

replied that it certainly is not. I have been asked whether the paper with which this session is to be opened could be considered in the slightest degree commercial because it is to be presented by a man who has been identified rather closely with certain paving interests. I assure you that it can not. The title of the paper accurately indicates its character, namely, "The Economics of Highway Construction," and I will introduce to you the author, Mr. Clifford Richardson.

THE ECONOMICS OF HIGHWAY CONSTRUCTION

By CLIFFORD RICHARDSON

Consulting Engineer, New York, N. Y.

There is nothing which should commend itself more to the support of the people than the movement for the improvement of our highways. Too much money cannot be spent for this purpose, if it is available and expended in a rational way and with due consideration of the financial problems which it involves. There is no question but that better roads than we now possess are not only desirable, but in many cases necessary, but the point to be considered is, how can we finance their construction if we are to build them on the expensive scale which is now proposed and, in many cases, is being carried on, without being involved in difficulty. In other words, the economic aspect of the road problem has not been sufficiently considered.

From the point of view of the economist the highway problem is one involving the most complex principles of his science. Highways are economic goods, that is to say they involve an outlay for construction and a continuous cost of maintenance. They are things which satisfy human wants and are not to be had free. They are public goods, as a rule, today, since their use is supplied gratuitously to the public. The toll road was not a public good but merely an economic one. The toll road is not, however, a matter for serious consideration at the present time, as it no longer exists to any extent. The economic question relating to highway construction is how shall the expense of building roads and maintaining them in the most satisfactory and economical manner be met, and who shall provide for it. Shall it be assessed on all persons alike or more largely on those who use the roads? How shall the money involved

be raised and what are the most economical and equitable methods of so doing?

On this subject Prof. F. W. Taussig, of Harvard University, in his recent book, "Principles of Economics," has this to say:

"Public goods are economic goods supplied gratuitously to individuals, yet involving effort and consequent expense to some one. Though free to the users, they are not free goods. Such is water at the public fountain; such are public education, parks, museums, free concerts, bridges and highways. What goods shall be public and by whom the expense of providing them shall be met—whether by levy on all persons or on some only—these are the problems as to public functions and as to taxation for defraying their expense; among the most difficult and far reaching that the economist has to deal with."

According to the same author, wealth or economic goods is a term which serves to describe the subject matter with which economics has to deal; those things which men want, which are not free, and which present the problem of effort, of satisfaction through effort, of the organization of industry. It must be remembered that all forms of material wealth wear out in the course of time, and this is particularly true with highways. Highways are a temporary and not a permanent form of improvement unless the foundation and drainage provided are of a stable nature, and can be considered as such. Under no circumstances can the surface be looked upon as being permanent.

If the capital invested therein is to remain unimpaired a certain sum must be set aside every year to replace deterioration and wear. It depends upon this whether a highway shall remain capital or disappear through depreciation.

Prof. Taussig remarks:

"If a spendthrift wishes to borrow and gives a sufficient guarantee of payment, by mortgage or other pledge, a loan is made to him as freely as to a business man who proposes to put up a factory. But the loan to the spendthrift has nothing to do with making capital. It leads to the same results as if the original owner of the surplus sums had devoted them to present use. It causes labor to be directed to producing truffles and champagne, not to factories and machinery."

From this point of view it would appear that many of our highways may be looked upon, under the system under which they are constructed and maintained, as "truffles and champagne," since at least 75 per cent. of their cost is for work of a temporary nature and since a large and most destructive part of the travel which uses them consists of pleasure vehicles and but a small proportion of what may be classed as productive traffic, the transportation of merchandise and for business purposes in general. If our states are rich enough to afford such an expenditure and meet the cost through revenues collected during the life of the surface of the road, regarding them as mere satisfactions and only in part as utilities, the problem becomes a very simple one. As a matter of fact, a large proportion of the improved highways which have been built in the last five years, would never have been constructed on the expensive scale that they have been, were it not for the demand for them by persons who use them as a mere satisfaction for the pleasure of motoring, although it must be recognized that the motor truck and the traction engine are gradually becoming a serious feature in the problem.

It would seem, therefore, that the cost of these expensive roads should be met, at least in some part, by revenues derived from the taxation of motor travel, and that a large portion of their maintenance should be paid for from the same source, since the majority of the vehicles which now use our roads are of this description and it is for them that the roads are particularly built. The expensive modern bituminous road could certainly be dispensed with if motor travel were done away with. They are, therefore, maintained largely for this form of travel alone, and for the greater part for pleasure and not for traffic.

The manner of financing road construction is carried out more carefully in Great Britain than in the United States. Road construction is usually paid for there with money raised by loans, but only with the approval of the Local Government Board of the character of the work and for a period not exceeding the life of the work, with suitable provision for the amortization of the debt. In addition the Government Road Board, which has been recently established for assisting the local authorities, distributes according to its good judgment, the proceeds of the license

tax on motors, varying from five to two hundred and five dollars per annum, and of a tax on motor spirit of six cents a gallon, a fund which will amount in 1912 to over six millions of dollars, and which will increase from year to year. It would seem that something of this description must be done in our states. At present this is realized to a certain extent in some of them, where a graded tax upon motors is in force, depending in amount upon the horse power of the vehicle. The tax on gasoline has not even been proposed, but it must come in time to place the burden of the cost, of maintenance at least, in part where it belongs.

Should such a tax be imposed in New York State, where 100,000 motor vehicles have been licensed in the year 1912, and assuming, according to Howard C. Coffin, that the average motor car runs 4,000 miles per annum, the entire motor mileage on the roads of the state would be 400,000,000. On a conservative estimate that a gallon of gasoline is equivalent to 15 miles of car travel, and it is probably not more than 10 with the more powerful cars, about 27,000,000 gallons of gasoline would be burned per annum in New York state. If this were taxed six cents a gallon the revenue would be $1,620,000, a sum which would go far when combined with the fees obtained for licenses, in maintaining the surfaces of our main arteries of communication, and place the burden of their upkeep where it properly belongs.

In a few localities in America the cost of road construction is met by general taxation. In most states, however, the custom of meeting the expense incurred by long term state or county bond issues is in vogue.

The state of Maine, in September, 1912, voted for a bond issue to run 41 years. Massachusetts, up to and including 1912, issued bonds for road construction for a period of 30 years, but, realizing that this was not sound finance, will issue bonds in 1913 for a period of 15 years only. Rhode Island has issued bonds in 1906, 1909 and 1912 to run for 30 years. Connecticut in 1911 authorized the issue of $6,000,000 of 25-year bonds, of which $1,000,000 shall be used for the improvement of public roads. and two millions for trunk line improvement. The state of New York has already issued $50,000,000 of 50-year bonds, and at the election this year authorized the issue of

$50,000,000 more for highway construction and improvement. Pennsylvania is to vote in 1913 for a similar bond issue. Maryland's bonds for highway construction have wisely been limited to a term of 15 years. Ohio has recently defeated a proposition to authorize 50-year bonds. Missouri's bonds are for a similar term of years, and Kansas has provided for bonds to be paid in not less than ten annual installments. Colorado submitted at the last election a proposition to issue $10,000,000 of 50-year, 4 per cent. bonds for the construction of state roads at the rate of $1,000,000 per year.

Many of the states issue no bonds, but the counties do so, and for long periods, which are equally as objectionable as the state bonds.

The issue of $50,000,000 of 50-year bonds at 4 per cent. by any state, will result in a cost of, at least, $116,350,000 at maturity. The average cost of roads constructed under such an issue in New York state, has been over $13,000 as paid for, but at the time of the redemption of the bonds the cost will have reached slightly over $30,000 per mile. But a small portion of this expenditure, that is to say, the money expended in relocating and draining and the construction of foundations of roads, certainly less than 25 per cent., can be looked upon as an asset, the benefit of which may be expected to extend through several generations. During the term of 50 years for which the bonds are issued, a vast additional expenditure will be, or should be, incurred for the maintenance of these roads and for the replacing or renewing the surface at intervals which cannot be more than 10 to 15 years apart at the outside. For this work further funds must be obtained, either by legislative appropriation or by the sale of further bonds on the same terms. It is fair to say, however, that in the period over which such bonds extend and before they are paid, the taxpayers will have been called upon to expend not only the original $30,000 per mile called for by the money expended and derived from the sale of the bonds and the interest and sinking fund, but, an even larger sum for maintenance and for the renewal of the surface. In New York state it appears that about 3,650 miles of highway have been completed, or are under construction, under the $50,000,000 bond issue. It has been stated that the value of taxable real estate in New York

per mile of highway is only about $100,000. It appears, then, that the total cost of even this limited area of highways in the state would amount to half the value of the assessed value of the property per mile of road. There is a vast extent of roads beyond this which must be provided for, and for which the second issue of $50,000,000 of bonds has been voted. It would seem that this is only making the matter worse, as far as involving the state in debt is concerned. The amount of money involved is sufficient to demand careful attention on the part of the taxpayers of New York state and others proposing to finance their road construction on the same basis, and to make them pause before they decide to continue such a policy.

The folly of purchasing a motor car by the individual from the proceeds of the mortgage of his property, without regard to how this can be paid off is generally recognized, whereas the construction of expensive roads over which to run such a machine which are paid for with money raised from bonds having a long time, 20 to 50 years, to run, and which are a charge on the state, the county or the town, is seldom looked upon from the same point of view, although the life of the motor and the road are equally short. Both the cars and the roads are luxuries, having short lives, and their cost should be provided for during this period and not postponed to some indefinite date.

It must, of course, be recognized that the construction of improved roads will increase the value of property to an enormous extent, and the revenue derived therefrom accordingly. This is to a certain extent a justification for such bond issues, but it does not in any sense justify such an issue from an economic point of view.

It has recently been asserted that there is no more reason why the building of highways with the proceeds of bond issues should be criticised than the issuing of bonds by steam railroads. This is quite true, but a railroad management which would issue long term bonds to purchase rails or ties, which have a short life, is equally open to the criticism of expending the funds obtained by bond issues as for the construction of road surfaces which have an equally short life. Bonds are never issued by railroads, which manage their finances conservatively, for the purchase of rails and ties, and where they are issued for equipment purposes,

the period does not extend beyond the life of the equipment. A railroad, conservatively managed, pays for its rails and maintenance of way, out of its earnings, and not by the proceeds of long term bonds which would eventually make the maintenance cost twice as much as it otherwise would be. There is no assurance of permanence, either in rails or in road surfaces. They are both known to deteriorate rapidly with use. On the other hand, there can be no objection, either in railroad or highway construction, to the borrowing of money by bond issues extending over long periods, where it is expended on permanent construction, such as the improvement, in the case of railroads, of the roadbed, or building stations, or, in the case of highways, of the location, relocation, or construction of foundations of a road. If the $50,000,000 to be realized by the next bond issue in New York state were expended for concrete foundations, for drainage and for improved location and reduction of grades, it would be well expended, and such work being permanent might well be distributed over a number of generations, but for the building of surfaces and their maintenance with the funds obtained by such bond issues, there can, in the writer's opinion, be no economic justification.

In conclusion, the writer would say that the demand for an improved form of surfaces upon our highways is so insistent and will, eventually, be so necessary owing to the advent of the motor truck, that they will be built under any circumstances, whether with due regard to the principles of economics or not. His object, however, is to call the attention of the taxpayer, the highway engineer and legislative authorities to the economic side of the question, as a warming of what may result if these are neglected. The subject has been considered in greater detail in a paper prepared by the writer for the Third International Road Congress, to be held at London, England, next June, but attention is called to it at this time and place to permit of its discussion.

PRESIDENT LEWIS: Gentlemen, we are fortunate in having to open the discussion of this most important question, the Superintendent of Highways of a state which but seven years ago authorized the issue of $50,000,000 of bonds for highway improvement, and within a month has

authorized $50,000,000 more, or $100,000,000 within about seven years. That shows the force of the concluding paragraph of Mr. Richardson—that we are going to have these highways anyway. I have the pleasure of introducing to you Mr. C. Gordon Reel, State Superintendent of Highways of New York.

C. GORDON REEL (State Superintendent of Highways of New York): Mr. President and Gentlemen:—It was with deep regret that Mr. Richardson's admirable paper on this very interesting and important subject was received only at the moment I was leaving Albany for Cincinnati. The limited time I have had precludes the full and detailed discussion which his paper so well deserves.

I will confine myself to the New York situation, since this is the one to which Mr. Richardson gives his particular attention, and, furthermore, is the one with which I am familiar.

In the first place the assumption that only 25 per cent. of our cost of construction is permanent and that 75 per cent. is perishable, is far from the fact. Taking the instances of our county highways 845, 632 and 681, and state highways 5002 and 5094, which are fairly typical and on which the excavation is light rather than heavy, we find the following percentages of permanent construction. 61 per cent., 61 per cent., 67 per cent., 50 per cent. and 43 per cent.—an average of 56 per cent. To this should properly be added the cost of engineering, permanent bridges, and right of way. It would be safe to assume that the percentage of permanent cost is at least from 65 to 70 per cent.

Furthermore, the tendency is to design our roads more and more liberally as regards alignment, grade and new location, so that in all probability the percentage of average permanent cost will approach, and perhaps reach, 75 per cent. in next year's construction. Our standard macadam road is now 9 ins. thick instead of 6 ins. as formerly.

The tenor of Mr. Richardson's paper would indicate that he thinks we pay for maintenance, at least in some part, from the proceeds of the bonds but this is not the case, since all maintenance is provided for by direct annual appropriation by the Legislature from the general funds of the state, supplemented by motor car license

revenues and the fixed amount of $50 per mile, paid by the towns in which the improved roads are located. Also cities of the second class pay 3 cts. per sq. yd., and cities of the third class and incorporated villages 1½ cts. per sq. yd. annually for maintenance.

I think the suggestion to place a tax on gasoline, as a fair measure of the amount motor vehicles should contribute, has merit, and that this would be a very proper subject for the next Legislature to consider.

There is more analogy between railroad construction as heretofore financed and our present method of highway financing than appears in the paper. It has been customary for railroads to build their lines, complete, from the proceeds of their bonds. The ensuing maintenance, of course, is provided for from earnings, but right here there is the distinct difference between the two propositions. Railroad earnings are definite, whereas highway earnings, however apparent and considerable, are still indeterminable. Our honored President, Mr. Nelson P. Lewis, of New York, stated on Tuesday that the ultimate cost of highways at $12,000 per mile would amount to $40 per acre for a distance of ½ mile on either side, and at a cost of $20,000 per mile, the ultimate cost would be approximately $80 per acre for this distance of ½ mile. We know of concrete instances where property values have doubled and trebled by reason of highway improvement and in one instance a piece of property in Rensselaer County, was recently bought for $500 and after an improved highway was built adjacent to it, the owner refused an offer of $3,000. With perhaps here and there a rare exception, it is a fact that the advance in the value of property adjacent to improved highways amounts to several times the cost of the improvement. Furthermore, this appreciation in value extends back from the highway for a considerable distance,—very much more than the ½ mile mentioned by Mr. Lewis.

While it is true that these highways are built largely to supply the demand of automobile traffic, it must be remembered that even the so-called pleasure (automobile) traffic means health-giving recreation, the stimulation of all kinds of business, and employment for a vast amount of high class labor. Furthermore, the rapidly increasing business motor traffic introduces an element of practical business value which no one can calculate.

That the people of New York state regard these bond issues as sound finance is evidenced by the majority of 368,000 given to the recent $50,000,000 bond issue; nor do these votes come from the localities immediately affected, but on the contrary, the people of New York City and Buffalo who pay almost 85 per cent. of the total amount, and who derive no direct benefit, gave the proposition very substantial majorities. It is significant that the measure submitting this bond issue to a vote of the people passed both branches of the Legislature without a single dissenting voice.

Our maintenance as heretofore administered, leaves much to be desired, and we must tend more and more toward the French system, so admirably described the day before yesterday by Monsieur de Pulligny.

Our people do not appreciate what this cost of maintenance in future will be. During the past year we expended some $3,000,000 and next year must expend approximately $5,000,000, and with the increasing mileage this annual charge for maintenance will soon reach the $10,000,000 mark. Great as this may seem, it is, however, not prohibitive when the vast resources of the state and the great benefits derived from good roads are considered. This cost of maintenance, while increasing in total amount is not increasing in direct ratio to the mileage improved, for the reason that for the first few years of highway improvement no provision was made for maintenance, and we are, therefore, called upon now to spend larger sums than would be the case had proper maintenance been provided for from the start. Then, too, this excessive maintenance comes about largely as a result of the experimental stage, both as regards construction and maintenance, and which we hope and think we are emerging from. Our new roads will be built more permanently, especially our state routes. We must recognize that there is no economy in low first cost when a construction is provided which is inadequate to the traffic We must accomplish less mileage and use more permanent types of construction.

In conclusion, while it is true, as stated by Mr. Richardson and by President Lewis, that a road costing $13,000 per mile will have cost $30,000 per mile by the time the bonds are finally liquidated, if this same road were paid

for in cash at the time of construction without any bond issue and the interest on the first cost computed for a similar term of years, the cost would similarly be a like amount, so it would seem to be as broad as 'tis long, the difference being that we can improve by virtue of bond issues as would be impossible had we to pay as we go.

W. P. BLAIR (Secretary, National Paving Brick Manufacturers' Association, Cleveland, O.): The paper by Mr. Richardson will apply very much as types of roads apply to the different conditions of country, or as roads apply to that which they are made to bear. There are parts of the country, I will grant, especially the eastern part of the country, where it perhaps would not be wise to issue long term bonds for the construction of roads; but there is no reason why, in many parts of the country, bonds may not be issued for the convenience of all.

I just want to give you one or two little figures that illustrate the value of improving the roads immediately rather than waiting to pay as you go. There are many places in this country where you have got to build a permanent road to have it of use at all. Take, for instance, 160 acres of land in the corn district of Illinois, that will produce this year, and has produced, an average of 14,000 bushels to each 160 acres over a very large area. There are gentlemen in this convention who have raised 15,000 bushels on 160 acres of land. The road frontage on a farm of that sort is about 2,640 ft. Suppose the road cost $10,000 or $15,000 a mile; there have been actual cases where a farmer has saved $3,000 in moving his crop off 160 acres of land, as against no road at all. Why should he pay as he goes when he can have the road on a bond issue to enable him to save on his annual crop the sum of $2,500 to $3,000 a mile. Why not? Then, I say that the theory laid down by Mr. Richardson must be applied only to the conditions of the country. To other conditions his ideas will not apply at all. (Applause.)

PRESIDENT LEWIS: Has anybody else anything to say on the subject?

MAJ. CROSBY: Mr. President, I want to make one little point. The audience evidently appreciates the seriousness of the financial question. Now, it is so vital a question that in our work as road builders, I think we should bear the seriousness of the question constantly in mind and

try to make as large a percentage as possible, of the work done under a bond issue, of a permanent character. In so doing we should always remember that there are no more permanent features of good road work than proper location and proper grades. (Applause.)

PRESIDENT LEWIS: We will proceed to the next paper on the program, which is another subject that has not heretofore received the consideration it has deserved, and that is the traffic census as a preliminary to road improvement. This will be presented to you by a gentleman who has perhaps given more careful and scientific study to this problem than almost any other road official in this country. I have the pleasure to present Col. Wm. D. Sohier, Chairman of the Massachusetts State Highway Commission.

[Col. Sohier's address consisted of an abstract of his paper, in which many tables and a large part of the statistics were necessarily omitted. The formal paper is printed here.]

THE TRAFFIC CENSUS AS A PRELIMINARY TO ROAD IMPROVEMENT

By COL. WM. D. SOHIER

Chairman, Massachusetts State Highway Commission

I am asked to speak to you about the traffic upon the roads.

The constantly increasing number of vehicles that are using our roads and the constant variation in the character of the traffic, changing from horse-drawn vehicles to motor vehicles, make necessary fundamental changes in methods of construction and maintenance.

Traffic and Roads

In the near future, no doubt, the heavy traffic on our roads will increase greatly, but will be carried by motor truck instead of by wagon, and then, possibly, as is now the case in England, the traction engine, weighing from ten to fifteen tons, may come into general use, hauling several trailers, each carrying from six to ten tons. The roads may have to supplement the railroads in transporting the freight to our larger cities. I believe, however, that in this country, with its tremendous development of trolley

roads, the rails and not the roads will take the bulk of this traffic. Certainly I hope so, as the poor road builder has enough hard problems to solve today without having to care for such additional and extremely heavy traffic.

Roads Must Carry the Traffic, and Economically

Naturally, the first and most important prerequisite of a good road is that it shall carry the traffic of all kinds that goes over it, comfortably, economically both for that traffic and for that road. The road must be so designed, built and maintained that it shall be at all times in proper condition to bear the traffic to which it may be subjected, and not only at the least cost to the user, but also at the least ultimate cost to the taxpayers, taking everything into account, viz.: interest, sinking fund, yearly maintenance and occasional resurfacing.

Traffic Indicates the Kind of Road Required

Road builders must consider not only the traffic that is now using any given road to be built or resurfaced or even maintained, but also what the traffic will be in the near future and how much it will increase and what changes will come in its character and volume. After these premises have been ascertained the road builder can, if he knows enough, build or resurface or maintain the road so that it will economically and satisfactorily carry its traffic in a series of years.

Knowledge of Traffic Necessary

Without that knowledge he is really entirely at sea; he is likely to make serious and costly errors by determining upon the wrong kind of construction and by selecting improper or unsuitable materials or methods. Naturally, also, he must select the type of road to be built, not only with regard to the traffic to be borne, but also with regard to the cost of the particular materials in any given locality, and the amount of money he can afford to spend.

Even were I competent, I could not discuss all these topics in one short paper, so I will stick to my theme "Traffic," with possibly a few remarks upon our experience, failures or successes, with certain materials and certain kinds of construction and maintenance compared with the traffic on the road.

Traffic Census on Roads in Massachusetts in 1909 and in 1912

The Massachusetts Highway Commission in 1909 had a census taken upon the state highways at 238 stations, scattered throughout the state; and in 1912 a similar traffic count made at 156 stations. While the count in 1912 was taken at fewer points than in 1909, it was felt that the percentages of increase and decrease could safely be used to indicate the traffic on other similar roads. A traffic census was also taken at the same time at quite a number of points around the city of Boston on roadways in Metropolitan and Boston park systems. The time and method of counting was identical at all points, and the full returns and methods will be found in our annual report for 1909, and again in the report for 1912, which will be printed and ready for distribution next March.

How the Census was Made

The vehicles actually passing on the road were counted by observers who were engaged for the purpose. All vehicles were counted for 14 hours a day (7 a. m. to 9 p. m.) for seven consecutive days in August, 1909, and again for seven days in October, 1909, at 238 stations, the daily census at each station being tabulated on a card. This same census was made again for like periods of time in August and October of this year (1912). At a few important points a count was also made at night, the census at these places covering the whole twenty-four hours.

Method of Tabulating

The cards kept by the census takers were printed and had a separate line for tabulating the following class of vehicles:

Kind of vehicle.	7 a. m. to 9 a. m.	9 a. m. to 11 a. m.	11 a. m. to 1 p. m.
Single horse (light vehicle)	......	......	......
Single horse (heavy vehicle)	......	......	......
Two or more horses (light vehicle)..	......	......	......
Two or more horses (heavy vehicle)..	......	......	......
Automobile (runabout)	......	......	......
Automobile (touring car or wagon)..	......	......	......
Motor (truck or omnibus)	......	......	......
Totals	......	......	......
Weather conditions	......	......	......

The cards were filled in by the observers and sent daily to the engineer, who in turn forwarded them to the main

office of the commission for tabulation. I present herewith sample cards, instructions, etc.

INSTRUCTIONS TO OBSERVERS

1. Examine carefully the card marked "Sample," sent to you with the cards upon which you are to keep your records, and be sure that you understand the method of keeping the tally.

THE COMMONWEALTH OF MASSACHUSETTS

MASSACHUSETTS HIGHWAY COMMISSION

TRAFFIC RECORD

1912

STATION NO. ....

TOWN-CITY ....

DATE ....

LOCATION OF STATION ....

....

(AT OR NEAR STA. .... MHC NOTATION)

KIND OF VEHICLE	7 A.M. TO 9 A.M.	9 A.M. TO 11 A.M.	11 A.M. TO 1 P.M.	1 P.M. TO 3 P.M.	3 P.M. TO 5 P.M.	5 P.M. TO 7 P.M.	7 P.M. TO 9 P.M.	TOTALS
SINGLE HORSE { LIGHT VEHICLE								
SINGLE HORSE { HEAVY VEHICLE								
TWO OR MORE HORSES { LIGHT VEHICLE								
TWO OR MORE HORSES { HEAVY VEHICLE								
AUTOMOBILE { RUNABOUT								
AUTOMOBILE { TOURING CAR OR WAGON								
MOTOR { TRUCK OR OMNIBUS								
TOTALS								
WEATHER CONDITIONS								

....
SIGNATURE OF OBSERVER

OBSERVER WILL NOT WRITE IN THIS SPACE

(SEE INSTRUCTIONS ON THE OTHER SIDE.)

SAMPLE TRAFFIC CENSUS OBSERVER'S CARD.

2. Your duties begin promptly at 7 o'clock in the morning and end at 9 o'clock in the evening for the seven days shown on the cards furnished to you.

3. In recording vehicles which pass your station, make a mark in the proper column and on the proper line for every

vehicle of the kinds called for on the cards, but do not record motor cycles, bicycles or pedestrians. Make an entry for every vehicle, no matter in which direction it is going or whether it has passed you previously. Entries may be made with a lead pencil.

4. "Light Vehicle" means a buggy, carryall, democrat wagon or any other vehicle, other than an automobile, which is used usually for pleasure or light business purposes.

"Heavy Vehicle" means a farm wagon, milk wagon, tip cart,

THE COMMONWEALTH OF MASSACHUSETTS

MASSACHUSETTS HIGHWAY COMMISSION

TRAFFIC RECORD

1912

STATION NO 608

TOWN-CITY Smithville

DATE Monday Aug. 27, 1909

LOCATION OF STATION House of F. A. Smith near road to Jonestown

(AT OR NEAR STA 241+60 M.H.C. NOTATION)

KIND OF VEHICLE	7 A.M. TO 9 A.M.	9 A.M. TO 11 A.M.	11 A.M. TO 1 P.M.	1 P.M. TO 3 P.M.	3 P.M. TO 5 P.M.	5 P.M. TO 7 P.M.	7 P.M. TO 9 P.M.	TOTALS
SINGLE HORSE LIGHT VEHICLE	33	14	8	7	19	23	18	122
SINGLE HORSE HEAVY VEHICLE	13	11	14	0	20	22	3	83
TWO OR MORE HORSES LIGHT VEHICLE	9	7	2	3	5	18	2	46
TWO OR MORE HORSES HEAVY VEHICLE	10	4	7	1	8	4	0	34
AUTOMOBILE RUNABOUT	44	61	21	7	38	31	47	249
AUTOMOBILE TOURING CAR OR WAGON	41	23	19	11	61	47	26	228
MOTOR TRUCK OR OMNIBUS	0	2	1	0	3	1	0	7
TOTALS	150	122	72	29	154	146	96	769
WEATHER CONDITIONS	Cloudy	Clearing	Fair	Fair	Fair	Cloudy	Showers	

Hannah M. Smith
SIGNATURE OF OBSERVER

OBSERVER WILL NOT WRITE IN THIS SPACE

(SEE INSTRUCTIONS ON THE OTHER SIDE)

SAMPLE OF CARD FILLED OUT

grocery or provision wagon or any other vehicle, except an automobile, which is used for carrying heavy loads.

"Automobile Wagon," "Motor Truck" or "Motor Omnibus," although not shown on sample, are to be counted in the same manner as other vehicles.

5. After you have recorded all of the vehicles during the period from 7 a. m. to 9 p. m., add your tally marks, and place the totals at the right of the card and at the bottom of the card in the spaces provided.

6. When you are sure the totals are added correctly, enclose the card for the day, after you have signed it, in one of the stamped addressed envelopes furnished to you and mail it at once.

7. Be sure that you use the right card each day (look at the date at the top of the card), and do not fail to record every vehicle, called for by the card, which passes your station.

8. If there is anything which you do not understand about the cards or these instructions, write at once to the division engineer, to whom you are to send the cards.

Tabulation and Computation

After the cards were received the number of vehicles observed at each point was tabulated and computed to show the average number of each class of vehicle passing the given point per day, the total number of vehicles and the total of each class, whether motor or horse-drawn.

When these figures were obtained the percentage of each class of vehicle using the particular road was computed and the percentage of the total of each class at all stations was computed as well.

DAILY AVERAGES OF OCTOBER, 1912, TRAFFIC RECORDS AT STATION — — — —.

(Taken for 14 hours each day for one week).

Horse Drawn Vehicles:
- Single horse, light .... ——— ....
- Single horse, heavy .... ——— ......
- Two or more horses, light.. ——— ....
- Two or more horses, heavy................ ——— ......

Automobiles:
- Runabouts .... ———
- Touring cars .... ———
- Commercial cars .... ———

Totals.
- Horse drawn, light .... ——— ......
- Horse drawn, heavy .... ——— ......
- All horse drawn .... ———
- Automobiles .... ——— ......
- All Kinds .... ———
- Horse drawn, light .... ———

Percentages: ——— ......
- Horse drawn, heavy .... ——— ......
- All horse drawn .... ———
- Automobiles .... ———
- Remarks ....

....

....

Computed by .... Checked by................

After these averages were computed for each of the 238 stations in 1909 and for the 156 stations in 1912, the total

average number of vehicles at all the various stations was added, the numbers ascertained, and from this was obtained the average number of vehicles passing at all the points where the count was made, as well as the average number of each class and kind, and the percentage that the vehicles of each class bore to the average total number.

Averages Only of General Value

This average number or percentage is interesting and illuminating for the purpose of showing average traffic and average changes in traffic, its character, etc., but is, of course, of no particular value in determining what the traffic to be carried on any particular road is. The actual number of vehicles varies too much at particular places; it varies from 67 vehicles a day to over 2,400. To be of value one must take the actual traffic on the road itself or use the figures taken at a place where there is similar traffic. The increase and decrease are of value, however, as showing changes in traffic and in its character and indicating what will take place in future.

To illustrate, on the Revere Parkway, in August of this year, there was an average of 64 horse-drawn vehicles daily and 1,808 automobiles, 97 per cent. of the travel was automobiles; whereas, in Somerville the average number of horse-drawn vehicles was 440 and the number of automobiles only 164, or 27 per cent. of the total, and yet the traffic at both places would go into the total and help to make the average.

Obviously, however, the two roads have such different traffic to carry that different materials and methods must be used.

Increases and Changes in Traffic from 1909 to 1912

In Massachusetts the traffic using our roads is constantly increasing, but it is changing much more rapidly than it is increasing. This is conclusively shown by the table on the following page.

The figures in that table represent a traffic count taken in 1909 and 1912 for fourteen days in each year, and from 7 a. m. to 9 p. m. on each day. You will note that the total number of vehicles using the road has increased 42 per cent. in three years, a notable increase in traffic surely.

INCREASE AND CHANGE OF TRAFFIC, 1909 TO 1912.

Kind of Vehicle.	1909 CENSUS, 238.5 Stations. Av. total No. per day.	Av. No. per day per Sta.	% of No. per Sta.	1912 CENSUS, 156.5 Stations. Av. total No. per day.	Av. No. per day per Sta.	% of No. per Sta.	Increase or decrease, %.
Motors.							
Runabouts	4,958.5	20.8	8.5	5,819.0	37.2	11	+79
Touring cars.....	17,950.5	75.3	30.5	27,178.5	173.5	49	+130
Trucks	......	...	...	1,800.0	11.5	3	....
Total motors ..	22,909.0	96.1	39.0	34,797.5	222.2	63	+131
Horse-drawn vehicles:							
1-horse, light....	17,033.0	71.5	29.0	8,380.0	53.5	15	−25
1-horse, heavy ...	11,762.5	49.3	20.0	7,458.0	47.6	14	−3
2 or more horses, light	1,006.0	4.2	2.0	556.0	3.6	1	−14
2 or more horses, heavy	6,205.5	26.0	10.0	3,870.5	24.7	7	−5
Total horse-drawn	36,007.0	151.0	61.0	20,264.5	129.4	37	−14
Totals of all kinds	......	247.1	...	......	351.6	..	+42

This is not the most significant feature for the roadman, however. The change in the traffic is what we must consider and prepare for. Motor vehicles have increased in numbers on the average 131 per cent., from 96 to 222 a day; on the other hand the teams have decreased on the average 14 per cent., from 151 to 129 a day, making the net increase only 42 per cent.

Here again you do not realize all the factors until you analyze still further; light single-horse vehicles have decreased 25 per cent., two-horse light vehicles 14 per cent., while heavy single-horse teams have decreased only 3 per cent., and heavy teams with two or more horses have decreased only 5 per cent.

Motor Trucks

Equally interesting for the future may be the fact that while we had almost no motor trucks in 1909, in 1912 we have an average of over 11 per station per day, or about 3 per cent. of the total traffic in numbers and much more in weight. What will it be in the near future? That is one of the questions we must answer. The increase in motor trucks between our August and October census was

notable. The average number of vehicles at each station decreased 72 a day or 18 per cent., while the number of motor trucks actually increased 4 per cent. In one town there was an average of only one truck a day in August, while in October there were 27. In another town there were 27 a day in August and 49 in October.

You must realize that our count is taken all over the state, in the country towns as well as near cities, and the figure, 11 trucks, is merely an average.

On the state highways near the cities we often found from 50 to 75 trucks a day, and usually from 15 to 30. On some roads motor trucks constituted over 16 per cent. of the total number of vehicles and actually outnumbered touring cars. Merely to illustrate, I might state that on some of our roads we had 2,100 to 2,400 vehicles daily, and on many we had 800 to 1,000, and yet the average for the whole 156 stations was about 350.

Pleasure Traffic Around Boston

The census near Boston in the parks may be interesting, but it must be remembered that it is, in many instances, light pleasure traffic. The following figures relate to the census taken in August, 1912.

METROPOLITAN PARKS
(Mostly Pleasure Vehicles.)

Location.	Total of all vehicles.	Motor vehicles.	% motor to total traffic.
Lynn, Prescott Pl. & Shore Res.	1,530	1,411	92
Revere, Saugus River Bridge	1,872	1,808	97
Somerville, Alewife Bridge	491	474	97
Medford, Parkway and Main street	515	492	95
*Somerville, Wellington Bridge	2,528	2,174	86
*Milton, Mattapan Bridge	2,383	1,717	72
Medford, Malden River Bridge	1,884	1,848	98
BOSTON PARKS (All Classes of Vehicles.)			
Prince St., Jamaica Plain	1,934	1,715	89
Commonwealth Ave., a city residential street	3,009	2,634	88
Washington St., a suburban city avenue	1,109	671	60

*All classes of vehicles.

At the last two points there were daily 247 and 296 heavy teams.

Traffic at Night

We had a count made for 24 hours a day at a few points, and the result may be interesting, so I print a short table.

DAY AND NIGHT, 12 HOURS EACH—OCTOBER, 1912

	Automobiles, day.	Automobiles, night.	Vehicles (all kinds), day.	Vehicles (all kinds), night.	Total vehicles.	Perctge. at night.
Lexington	302	59	438	104	542	19
Watertown	373	72	671	141	812	17
Chelsea	103	10	358	53	411	13
Somerville	266	70	689	231	920	25
Boston	358	69	513	94	607	15

I computed several night and day counts for the two years to get an average, and found that on the average the night traffic constituted about 18 per cent. of the total traffic; consequently, one should add about 22 per cent. to the 14-hour day count to ascertain the total number of vehicles.

Increase in Travel Caused by Building a Good Road

In some instances this is caused more by a diversion of travel from other roads in the neighborhood, than it is by creating a new and pleasant route; in other places it is because a new and pleasant route is furnished, and, of course, always both causes enter in more or less. Naturally, automobiles have brought in traveling, and put many places upon the map which were not there before, especially in New York and New England, where the woods, lakes, mountains and seashore furnish the great recreation and vacation resorts for the whole country.

A Few Specific Instances to Illustrate

There are two or more routes from Boston, along the North Shore and to Maine and New Hampshire. In the town of Salisbury, on the main line to the large New Hampshire resorts, the new and better road has increased the travel in part, and the increase in touring has also increased the traffic. In 1909 we found an average of 185 vehicles a day passing over this road; in 1912, 586—an increase of 217 per cent. in three years. Automobiles had increased from an average of 135 a day to 405, or 200 per cent., and heavy teams from 25 to 97, or 288 per cent. Both causes you see operated.

At the same time on the same route in North Beverly and Hamilton where the roads were equally good in 1909

and 1912, the increase in travel was 34 and 74 per cent., the total number of vehicles at all three points in 1912 not being very different. Salisbury with a good road had caught up, that was all.

Another illustration which probably indicates a diversion to another route because of the building of a new road is the Newburyport Turnpike, from Boston to Newburyport. This route is hilly, and in 1909 it was in very bad order, very rough and narrow, with many holes and rocks, and bumps the whole length. During the last three years we have been improving the road, working in eight towns, over 26 miles of road, and using a part of our motor vehicle fees on it, making a reasonably good gravel road, at an expense, so far of about $1,000 a mile.

Taking points on this route, which is the shortest and most direct between Boston and Newburyport: At Lynnfield there were only 81 vehicles a day in 1909, while in 1912 there were 333, an increase of 300 per cent. Automobiles had increased from 34 to 249 a day. At a point farther away from Boston on this same route in 1909 there was an average of from 6 to 7 teams a day, and 6 to 7 automobiles; a total of 13 vehicles a day. In 1912, after the road had been improved, there were 29 teams instead of an average of 6 a day, and 80 automobiles in place of 6. The total number of vehicles had increased from 13 a day to 108—seven times as many vehicles today use that road daily. This travel will more than double in a short time as soon as the road condition becomes known and it is routed in the automobile books. Then we shall be forced to oil it, and I hope the automobile fees will be sufficient for this kind of work. On many of these through routes the towns are poor and cannot possibly afford to oil their roads. Many times also, as in the case of this road, the through route is of no interest to the town, or its inhabitants—no one lives on it.

Attractive Scenery Made Accessible—Country Developed—Values Increased

On Cape Cod in Massachusetts there is nothing but sand. The roads formerly were sand, and were deeply rutted; often for 30 or 40 feet in width they were practically ploughed into furrows where each teamster had attempted to find a new rut with a little grass on top, in the vain

hope that his team could pull over the hill with at least one-half a ton. Often and often he was disappointed.

First, many of these roads were more or less hardened and greatly improved by using clay, or even loam, to help pack the sand. This worked reasonably well with very light traffic, but in a long dry spell the roads often went to pieces.

Now the main lines on Cape Cod are mostly state highways, although often the town paid a large part or the whole of the cost of building them. Many of these roads are now macadam. The automobile traffic increased so much that they were rapidly being destroyed and we have had to oil most of them; again using motor vehicle fees.

During the last few years, however, we have been building many miles of road, where the team traffic was not heavy, of hot asphaltic oil and sand, making reasonably satisfactory roads at a cost of one-third to one-quarter, or even less, of the cost of macadam in that locality. I merely mention this in passing as my topic is traffic, not construction.

Here again the increase in traffic shows how a good road attracts travelers. A sand-oil road replaced a sand road, and here is the result: In one town in 1909, there were 118 vehicles, of which only 41 were automobiles; in 1912 (only three years later) there were 331 vehicles, and 142 of them were automobiles. The total traffic had increased 180 per cent. but—mark this—over 100 more automobiles passed there every day. The tourist had arrived and was spending his money. Don't you think seashore homes will be erected, and land values increased?

Take another illustration, on the main line to Provincetown, which is at the tip end of Cape Cod. In 1909, 17 automobiles a day; in 1912, 70. The total vehicles using that road increased from 63 in 1909 to 102, or 62 per cent., but—mark this—the number of vehicles increased 39 a day, while the automobiles increased 53 a day. Some of the teams had been replaced by automobiles.

Another noticeable point is, that taking the whole route from Boston to Provincetown, and counting the traffic at eight points scattered along the route, from 8 miles out of Boston to 140 miles, the average increase in traffic is only 41 per cent., whereas at these points a long way down on the Cape, it is 180 per cent. and 62 per cent., respectively.

Jacob's Ladder

Our commission has been building on the main line between Springfield and Pittsfield—the Connecticut and the Berkshire Valleys. It has built around Jacob's Ladder, the worst place on that route, and there is now a reasonably good road all the way—no place bad enough to deter anyone from touring, though about nine miles are still ordinary country dirt roads. This route is much used by automobiles coming from Albany and New York state points, and going to the seashore or mountains. Here again, at one point the vehicles using the road a day increased from 234 in 1909 to 348 in 1912, about 45 per cent.; and at another point they increased from 183 a day in 1909 to 325 in 1912, an increase of 72 per cent. The automobiles at the first point increased from 77 to 182, or more than double; and at the second from 59 a day to 209 a day, three to four times as many motors using the road every day in 1912 as used the same road in 1909, and the end is not yet.

Weight of Traffic an Important Consideration

After all, it is not numbers which tell the story, it is weight, and it is not weight alone but the vehicle by which it is transported, whether by horses or by motor. It is not the tractive power alone that makes the difference, but the tires which support the vehicle; whether iron or rubber comes in contact with the road; whether the vehicle is pulled over the road or propels itself, and thus pulls upon the road surface. All of these considerations, in my opinion, are probably not as important on many road surfaces as the actual weight imposed upon the road per inch width of tire resting upon the road.

Narrow Tires Cause Most Damage

In other words, heavy loads supported upon narrow iron tires, having a weight of over 600 to 800 lbs. for each inch in width of the tire, do vastly more damage to most, if not all, our roads than do very much heavier loads where the weight per inch width of tire is less. Such loads carried on such narrow tires will practically destroy any road surface, except a pavement, in a few months if there are many such vehicles using the road every day.

Determination of Weight of Traffic

After careful study they have adopted in England an assumed weight, or coefficient, for each kind of vehicle using the roads, in order to make a fair comparison of the traffic upon different roads where the traffic varies, and to more nearly show what the road must support. It is quite similar to the formula in use in France and on the Continent. I have therefore used it, both for want of a better one and also because it gives a fair basis of comparison. I submit a table showing the weight of the road traffic on our roads computed in this way, with the coefficient reduced to our tons of 2,000 lbs. each in every case, both on the English and our Massachusetts roads.

WEIGHT OF TRAFFIC ON MASSACHUSETTS ROADS

	1909			1912		
	Av. No Per Day Per Sta.	Assumed Weight Tons.	Wt. Tons Per Day Per Sta.	Av. No. Per Day Per Sta.	Assumed Weight Tons.	Wt. Tons Per Day Per Sta.
MOTORS						
Runabouts	20.8	1.43	29.7	37.2	1.43	53.2
Touring cars	75.3	2.28	167.9	173.5	2.23	386.9
Trucks	....	6.25	....	11.5	6.25	71.9
Totals...........	96.1	....	197.6	222.2	....	512.0
HORSE-DRAWN VEHICLES						
1 Horse—Light....	71.5	0.36	25.7	53.5	0.36	19.3
1 Horse—Heavy...	49.3	1.12	55.2	47.6	1.12	53.3
2 or more Horses—Light	4.2	0.54	2.3	3.6	0.54	1.9
2 or more Horses—Heavy	26.0	2.46	64.0	24.7	2.46	60.8
Totals	151.0	....	147.2	129.4	....	135.3
Totals of all kinds.	247.0	....	344.8	351.8	....	647.3

Here again not only are the changes in traffic notable but the weights are even more important. The average weight per station per day of the motor vehicles in 1909 was 197 tons, in 1912 it was 512 tons. For horse-drawn vehicles it was 147 tons in 1909 and only 135 tons a day in 1912.

The weight of automobile traffic has increased 160 per cent. in three years, while the weight of horse-drawn vehicles has actually decreased 8 per cent. in the same time. While this is true, note what happened—the motor truck has come in with an average number of trucks of 11½ per station, and their weight is nearly 72 tons a day. Weight of teams decreased 12 tons a day; trucks came

in with a weight of 72 tons a day—making good the loss in team weight six times over.

Some English Traffic

A comparison may be of interest, and so I print the foregoing traffic statistics taken in 1911 on the main roads in the County of East Sussex in England, at 101 stations, and in the County of Kent, at 47 stations.

COUNTY OF EAST SUSSEX, 101 STATIONS.

	Av. Total No. Per Day	Av. No. Per Day Per Sta.	Per Cent.	Average Total Wt. Tons Per Day	Av. Wt. Tons Per Sta.
Motors	9,115	90.2	47.5	3,885	384.7
Horse-drawn vehicles.	10,087	99.9	52.5		
	19,202	190.1	100.0		

COUNTY OF KENT, 47 STATIONS.

	Av. Total No. Per Day	Av. No. Per Day Per Sta.	Per Cent.	Average Total Wt. Tons Per Day	Av. Wt. Tons Per Sta.
Motors	5,171	110.0	39.8	29,844.6	635
Horse-drawn vehicles.	7,825	166.5	60.2		
	12,996	276.5	100.0		

Two Facts of Considerable Interest

First—Motor vehicles constituted only from 40 to 47 per cent. of their traffic in 1911, whereas they made up 63 per cent. of our traffic in 1912, while in 1909 they made 39 per cent. of our traffic.

Second—In total weight of traffic the roads in East Sussex had about the same average weight per station as did our roads in 1909 (384 tons and 344, respectively), whereas, the County of Kent in 1911 had a little less weight of traffic per station than we had on our roads in 1912 (635 tons in Kent, 647 tons in Massachusetts).

Width of Roadway a Vital Consideration

The width of the roadway must be taken into consideration, as it is manifest that what wears out a road is the actual weight and volume of traffic that has to be sustained by each inch in width of the road surface. Consequently, I have had some tables prepared showing the assumed actual weight, in tons per day, passing over each yard in width of the macadam roadway on certain roads in Massachusetts.

I selected a teaming road near Boston (Medford); a teaming road in Shrewsbury near Worcester (population, 150,000); one road at a popular seashore resort (Beverly East); a main through line with local travel, also 20 miles from Boston (Beverly North); a station 10 miles from

Boston (Weston) on the through line to Worcester, with some local travel; and a second station on a fairly heavily traveled road leading into Boston.

For purposes of comparison I also print like tables of the traffic upon the London-Folkestone Road, one of the main roads in England, leading into London. [See pages 225, 226 and 227.] It was made to show what the traffic was over the piece of road the Road Board selected, on which they placed the many experimental pieces of road which are being built and are to be carefully measured to show actual wear upon the roads. It was selected as a typical, heavily traveled, English main road; heavy suburban travel, not city traffic.

Kind of Traffic

A careful study and comparison will show several interesting things.

(1) The English travel in numbers does not differ very materially from ours; we often have more.

(2) The weight carried per yard width in Massachusetts is sometimes more and sometimes less; not so very different.

(3) It is in the kind of traffic carried that the greatest difference appears. It is most significant.

Lorries, traction engines, omnibuses, motor trucks, on the English road constitute one-half of the total weight carried per yard width of roadway. Think of it for a minute, one-half of the total traffic carried by heavy self-propelled vehicles, and often on iron tires, whereas, on our roads, that traffic is only a very small percentage of the total, just about 10 per cent. instead of 50 per cent., and it is all carried on motor trucks with rubber tires, and none of it on iron tires, a most important consideration.

Character and Volume of Traffic Affect Both Construction and Maintenance

This is not my topic, but as any traffic study is of value only for the purpose of helping the road engineer determine the type of road to build and the best method of maintenance, a few words on this subject may not be out of place.

Much Motor Traffic Makes Binder Necessary

The experience in Massachusetts and elsewhere has shown conclusively that large numbers of swiftly moving

TABLE SHOWING COMPARISON OF WEIGHTS PER YARD WIDTH OF CARRIAGE WAY ON ROADS LEADING INTO BOSTON, MASS., FROM ROAD TRAFFIC CENSUS OF 1909 AND 1912.

Classification of Vehicles.	Aver. number of vehicles per day.	Assumed aver. weight of vehicles.	Total weight in tons per yd. width of carriageway per day, census 1912.	Total weight in tons per yd. width of carriageway per day, census 1909.	Increase or decrease, %.
SHREWSBURY (OBSERVATION STA. NO. 310) WORCESTER—BOSTON ROAD.					
Motor Vehicles:					
Runabouts	76	1.43	21.7	90	+141
Touring Cars	407.5	2.23	181.7	87.4	+108
Trucks	17	6.25	21.2	...	...
Horse Drawn Vehicles:					
Light Vehicles, one horse.	64	0.36	4.6	7.1	—35
Heavy Vehicles, one horse	60.5	1.12	13.6	20.9	—35
Light Vehicles, two or more horses	4.5	0.54	0.5	0.4	+ 25
Heavy Vehicles, two or more horses	36	2.46	17.7	29.5	—40
Totals	665.5	....	261.0	154.3	+ 69

Remarks.—Carriage Way, 15 ft.

Classification of Vehicles.	Aver. number of vehicles per day.	Assumed aver. weight of vehicles.	Total weight 1912.	Total weight 1909.	Increase or decrease, %.
MEDFORD—SOMERVILLE (OBSERVATION STA. NO. 342) BOSTON—LAWRENCE ROAD.					
Motor Vehicles:					
Runabouts	44.5	1.43	6.8	1.8	+278
Touring Cars	121.5	2.23	29.0	12.9	+125
Trucks	49	6.25	32.8	....	...
Horse Drawn Vehicles:					
Light Vehicles, one horse.	47.5	0.36	1.8	1.9	— 5
Heavy Vehicles, one horse	198.5	1.12	23.8	18.6	+ 28
Light Vehicles, two or more horses	2	0.54	0.1	0.5	—80
Heavy Vehicles, two or more horses	183.5	2.46	48.4	28.9	+ 67
Totals	636.5	....	142.7	64.6	+121

Remarks.—Carriage Way, 28 ft.

Classification of Vehicles.	Aver. number of vehicles per day.	Assumed aver. weight of vehicles.	Total weight 1912.	Total weight 1909.	Increase or decrease, %.
BEVERLY (EAST) (OBSERVATION STA. NO. 331) BEVERLY—MANCHESTER ROAD.					
Motor Vehicles:					
Runabouts	168	1.43	38.8	30.7	+ 26
Touring Cars	849	2.23	315.5	246.8	+ 28
Trucks	56.5	6.25	58.8	....	...
Horse Drawn Vehicles:					
Light Vehicles, one horse.	274.5	0.36	16.5	26.2	—37
Heavy Vehicles, one horse	118.5	1.12	22.1	29.3	—25
Light Vehicles, two or more horses	29.5	0.54	2.7	5.2	—48
Heavy Vehicles, two or more horses	70.5	2.46	28.9	40.2	—28
Totals	1,561.5	....	483.3	378.4	+ 27

Remarks.—Carriage Way, 18 ft.

TABLE SHOWING COMPARISON OF WEIGHTS PER YARD WIDTH OF CARRIAGE WAY ON ROADS LEADING INTO BOSTON, MASS., FROM ROAD TRAFFIC CENSUS OF 1909 AND 1912. (Continued.)

Classification of Vehicles.	Aver. number of vehicles per day.	Assumed aver. weight of vehicles.	Total weight in tons per yd. width of carriageway per day, census 1912.	Total weight in tons per yd. width of carriageway per day, census 1909.	Increase or decrease, %.
WESTON (OBSERVATION STA. NO. 344) WALTHAM—MARLBOROUGH ROAD.					
Motor Vehicles:					
Runabouts	115	1.43	27.4	18.4	+ 49
Touring Cars	533	2.23	198.1	95.5	+108
Trucks	30	6.25	31.2	....	...
Horse Drawn Vehicles:					
Light Vehicles, one horse.	167	0.36	10.0	13.0	—23
Heavy Vehicles, one horse	98	1.12	18.3	20.5	—11
Light Vehicles, two or more horses	5	0.54	0.4	0.7	—43
Heavy Vehicles, two or more horses	59	2.46	24.2	28.7	—16
Totals	1,007	....	319.6	176.8	+ 81

Remarks.—Carriage Way, 18 ft., October Census only.

Classification of Vehicles.	Aver. number of vehicles per day.	Assumed aver. weight of vehicles.	Total weight in tons per yd. width of carriageway per day, census 1912.	Total weight in tons per yd. width of carriageway per day, census 1909.	Increase or decrease, %.
NATICK (WEST) (OBSERVATION STA. NO. 345) FRAMINGHAM—BOSTON ROAD.					
Motor Vehicles:					
Runabouts	42	1.43	10	4.3	+132
Touring Cars	240	2.23	89.2	34.9	+155
Trucks	20	6.25	20.8	....	...
Horse Drawn Vehicles:					
Light Vehicles, one horse.	41	0.36	2.5	2.1	+ 19
Heavy Vehicles, one horse	61	1.12	11.4	8.0	+ 42
Light Vehicles, two or more horses	1	0.54	0.1	0.3	—67
Heavy Vehicles, two or more horses	22	2.46	9.0	5.3	+ 70
Totals	427	....	143.0	54.9	+160

Remarks.—Carriage Way, 18 ft., October Census only.

Classification of Vehicles.	Aver. number of vehicles per day.	Assumed aver. weight of vehicles.	Total weight in tons per yd. width of carriageway per day, census 1912.	Total weight in tons per yd. width of carriageway per day, census 1909.	Increase or decrease, %.
BEVERLY (NORTH) (OBSERVATION STA. 332B) WENHAM—BEVERLY ROAD.					
Motor Vehicles:					
Runabouts	83	1.43	19.8	18.6	+ 6
Touring Cars	342	2.23	127.1	73.2	+ 74
Trucks	46	6.25	47.9	....	...
Horse Drawn Vehicles:					
Light Vehicles, one horse.	73	0.36	4.4	7.7	—43
Heavy Vehicles, one horse	108	1.12	20.2	17.9	+ 13
Light Vehicles, two or more horses	5	.54	0.4	1.1	—64
Heavy Vehicles, two or more horses	116.5	2.46	47.8	27.7	+ 72
Totals	773.5	....	269.6	146.2	+ 84

Remarks.—Carriage Way, 18 ft.

TABLE SHOWING COMPARISON OF WEIGHTS PER YARD WIDTH OF CARRIAGE WAY ON ROADS LEADING INTO BOSTON, MASS., FROM ROAD TRAFFIC CENSUS OF 1909 AND 1912. (Continued).

QUINCY (EAST) (OBSERVATION STA. NO. 403) BOSTON—SO. SHORE ROAD.

Classification of Vehicles.	Aver. number of vehicles per day.	Assumed aver. weight of vehicles.	Total weight in tons per yd. width of carriageway per day, census 1912.	Total weight in tons per yd. width of carriageway per day, census 1909.	Increase or decrease, %.
Motor Vehicles:					
Runabouts	114	1.43	15.3	14.8	+ 3
Touring Cars	467	2.23	97.6	47.9	+ 84
Trucks	38.5	6.25	22.6	....	...
Horse Drawn Vehicles:					
Light Vehicles, one horse.	45	0.36	1.5	3.0	—50
Heavy Vehicles, one horse	216.5	1.12	23.7	20.5	+ 11
Light Vehicles, two or more horses	0.5	0.54	....	0.1	...
Heavy Vehicles, two or more horses	104.5	2.46	24.1	20.4	+ 18
Totals	986.0	....	183.8	106.7	+ 72

Remarks.—Carriage Way, 32 ft.

SIMILAR TABLE FOR AN ENGLISH ROAD.

LONDON—FOLKESTONE ROAD (BETWEEN LONDON COUNTY BOUNDARY AND SIDCUP).

Motor Vehicles:					
Not including cycles, omnibuses, lorries or traction engines	130.6	1.83	34.1	....	...
Lorries, omnibuses, traction engines	151.9	6.25	135.6	....	...
Horse Drawn Vehicles:					
Light Vehicles, one horse.	104.9	0.36	5.4	....	...
Heavy Vehicles, one horse	19.3	1.12	3.1	....	...
Light Vehicles, two or more horses	82.9	.54	6.4	....	...
Heavy Vehicles, two or more horses	247.1	2.46	86.8	....	...
Totals	736.7	....	271.4	....	...

Remarks.—Carriage Way, 21 ft., 6 A. M. to 6. A. M.

automobiles cannot successfully be carried over a water bound macadam road or over a gravel road. Such a road becomes raveled very rapidly, rutted and disintegrated. Our traffic studies indicate that from fifty to one hundred automobiles a day make the use of some dust layer or binder necessary. Possibly its use would prove economical on a

road where there is even less motor traffic. Remember, Massachusetts state highways seldom have city traffic, as they are located mostly on main roads in the country, although often near the cities and leading into them.

Bituminous or Other Permanent Construction Economical With Much Team Traffic

With the motor traffic which we already have, we are forced, we think, both for economy and for efficiency, where a road has a heavy team traffic as well, to adopt in construction or resurfacing some form of bituminous mixture for the upper two or three inches of the road surface, at least, or some stronger road, like concrete. We could show you many places where we believe such construction or reconstruction has been, and will be, economical.

Automobiles Only

On the other hand, we can also show you some oiled gravel roads which are satisfactory and very economical, if they are constantly and properly maintained, where there are large numbers of swiftly moving automobiles a day, in the summer months at least, but not many heavy, loaded teams. Some of these roads have 500 automobiles or more a day, and yet they are cheaply built and cheaply maintained. We can show you some roads built of sand and asphaltic oil of which the same is true, but, mark this well, these roads have very little heavy teaming on them. Heavy teams and many heavy motor trucks would rut such roads quickly and soon wear them out.

Maintenance

When the motor vehicle appeared in fair numbers upon our roads, we had in Massachusetts from 600 to 700 miles of state highways (we now have over 900), and they were mostly water bound macadam, with some few miles of gravel road. These highways had been built from one to fourteen years previously, very few miles had been resurfaced, and the commission had only $100 a mile a year for maintenance and resurfacing, and not that much except for the last few years. The maintenance of these old roads was our problem in 1908, and has been ever since. Automobile travel increased 40 per cent. a year and the total traffic 14 per cent. a year, and these roads must be maintained, or the state's money, borrowed on long time bonds, would be lost and wasted; the good roads would be gone, but the bonds would still remain to be paid.

Money Necessary

First, we had to get the necessary money. We obtained this from two sources. The state doubled its appropriation, giving us $200,000 a year instead of $100,000. We secured a larger motor vehicle fee and the right to use the net fees for the maintenance of the roads. These two sources of revenue for the last three years have provided us with about $500,000 a year for the roads, instead of $100,000; an average of $450 a mile a year, instead of $100. We think we are catching up; anyway we are at least holding our own.

Bituminous Binders and Dust Layers Used

We have saved many miles of our old roads by spreading a coat of asphaltic oil—light or heavy—or tar, over them. Today some asphaltic binder or dust layer has been used on over 80 per cent. of our state highways, and the only roads on which it has not been used are those located in the country districts where there is very light traffic. This year we have used nearly 2,000,000 gallons of bituminous material in construction or maintenance. Over 800 of the 930 miles of our state highways have received some form of bituminous treatment. We have resurfaced as many miles of road every year as we could compatibly with saving all our roads; using, where the traffic was heavy, a bituminous macadam on the top three inches.

Effect of Traffic on Bituminous Surfaces

I can only touch upon this subject, though I could talk all day and then only tell a part of what I think I know. We have four division engineers, each in charge of a particular district. I asked them all the same questions relating to the use of different tars, oils, asphalts, etc., and their opinion of the relative merits or demerits of each, both from a maintenance point of view and for economy. I secured four answers, all good, but all different. One had used tar on the surface successfully, another had not. One liked tar for penetration or mixing; another preferred an asphaltic compound. The same was true of the use of various asphaltic oils as a blanket coat, or as a dust layer. One preferred a heavy cold oil, another a heavier hot oil, and so it went.

There was, however, if you studied the traffic and other conditions carefully, a real agreement in all essentials.

Hence, I venture to state a few facts I think we know, as it may help the few road builders who do not know any more than we do.

Where Heavy Oils Fail

We have a good many miles of old macadam road which have been saved and maintained by one-half gallon of hot asphaltic oil spread upon each square yard of surface and properly covered with sand and pea stone or gravel. These roads have, many of them, worn three years, and in their fourth year are still in good condition. A few miles have worn four years and are now on their fifth year. The patching has cost but little (their treatment and maintenance might average from two to three cents a yard a year).

These roads often have very heavy automobile travel, possibly over 1,000 cars a day. They often have large numbers of teams daily. One has over 500 teams and 1,000 automobiles, and a heavy blanket oil surface has worn reasonably well for three years, and will a fourth, with a few exceptional places. This same road also has an average of 55 motor trucks a day.

Near two stations, where the teaming was heavy and excessive, for one-quarter of a mile in each place (out of four miles), the blanket oil failed. It crumbled, went into mud, developed holes and was disappearing. We have replaced the top three inches with an asphaltic bituminous macadam.

Heavy Horse-drawn Teams Cause Failure

The traffic study shows that it is not the number of teams, but heavy teams—two or more horses, heavy loads on narrow tires—that cause the failure.

The failure of roads treated with heavy oil has occurred on a few miles of road at certain places where it was clear that heavy horse-drawn teams were responsible. In two instances it was fifty to seventy-five ice teams a day, together with the other teams, carrying three tons or more each on 2½-in. to 3-in. tires. In a month the oil surface began to crumble and break up on the side of the road on which the loaded teams traveled. It lasted three months on the other side of the road where these teams came back empty. This same road, treated with the same oil, is still in good condition beyond these ice houses; in one case for three miles, in the other for fifteen or sixteen miles,

and the oil is three years old and still only needs patching. We could give many other illustrations tending to show the same results.

Light cold oil has been substituted as a dust layer and has proved reasonably satisfactory, though the stone, of course, is wearing out, and a bituminous macadam would probably prove economical.

One more instance of interest: Our Gloucester road, covered with a hot oil blanket, was rutting and wearing out quickly in 1909. A coal team was passing to some hotels three or four times a day during the summer (carrying six or seven tons of coal on narrow tires). A motor truck was substituted for the coal team, and the surface of the road, which had been oiled, was again in good condition. It has worn three years, and now only needs patching.

Hot Oil Blanket Surface

A hot oil blanket surface, made of a good asphaltic oil, will be economical and will carry large numbers of automobiles at high speeds (over 1,000 a day in summer) for several years, will carry large numbers of light teams (500 a day), and quite a number of motor trucks (50 or so a day), but will be destroyed by a large number of heavy teams, especially with narrow tires. Fifty or more such teams, farm teams, wood teams, or teams on narrow tires, will rapidly destroy the road surface. A surface coat of a good quality of tar will last satisfactorily under a large amount of automobile travel, but usually, in our experience, it has to be renewed more often than a good quality of oil.

In all cases, I assume that all holes and depressions will be filled before tar or oil is used, that the bituminous material is evenly distributed and is sufficiently covered and kept so that it will not pick up, and that all holes that develop are patched at once as soon as they form. Constant repairs, at a cost of one cent to two cents a square yard a year will save an expenditure of from 40 cents to $1 a square yard for the resurfacing of these bituminous surfaces if they are allowed to go to pieces. They will do it in a year, or two at the most, if not cared for properly.

When these surface treatments fail, as they will where the traffic is extremely heavy—meaning heavy in weight of vehicles, not numbers of vehicles—then you must select some more permanent form of construction and

reconstruct your road as soon as possible. It will prove to be true economy in the end, and the end is not far off.

Light cold oils, water gas tar, Tarvia B and the hundred and one different products on the market, dust layers, etc., prevent motors from raveling roads.—These materials may be economical and work satisfactorily for small team traffic (30 to 50 a day) and medium automobile traffic (50 to 100 a day) provided the road is not one where high speeds are usual. They may also help to preserve the road from the effect of automobile traffic where the team traffic is too heavy, or the loads are carried on such narrow tires that a hot oil blanket surface will not wear satisfactorily, until money becomes available to resurface the top three inches with some form of bituminous macadam.

Conclusions Summarized

With much hesitation I have prepared a table showing as nearly as I can the results we have observed after four years of experience with bituminous materials, comparing these results with the traffic going over the road in 1909 and again in 1912.

I realize fully that more experience will undoubtedly cause me to change or modify some of my present opinions, but I submit my present ones for what they are worth as indicating the result of our experience in Massachusetts.

The quality of gravel or other material and the speed of motor vehicles in particular localities are important factors and account for the above minimum and maximum variations.

We have not yet determined to our satisfaction the weight of traffic which makes it more economical to use a bituminous macadam, either tar or asphaltic products by penetration with a sealing coat of tar or asphalt, or by the mixing method, but we believe that or some such method would be economical and desirable where the team traffic is so heavy (to wit: 75 to 100 heavy teams on narrow tires with two or more horses), that a heavy, hot oil blanket surface will not carry the traffic but fails within the year.

We have several such bituminous macadam roads which have stood for three or four years very well, indeed; but time alone will determine the ultimate economy. In sur-

TABLE SHOWING RESULTS OF OBSERVATION OF TRAFFIC ON MASSACHUSETTS ROADS.

AVERAGE DAILY TRAFFIC.

Standard road 15 feet in width, with 3-foot gravel shoulder on each side.

	Light teams.	Heavy teams, 1 horse.	Heavy teams, 2 or more horses.	Automobiles a day.
A good gravel road will wear reasonably well and be economical with	50 to 75	25 to 30	10 to 12	100 to 150
Needs to be oiled with	......	......	......	over 150
Oiled gravel fairly good either hot or heavy cold oil ½-gal. coating (cold oil must be used yearly)	75 to 100	30 to 50	20	500 to 700
Water bound macadam will stand with	100 to 150	175 to 200	*60 to 80	Not over 75 at high speed
Dust layer will prove serviceable on such macadam with	......	......	......	50 to 100
Macadam will then stand (but the stone wears, of course), with.....	......	......	......	300 to 500
Water bound macadam with hot oil blanket coat will be economical with	250 to 300	75 to 100	25 to 30	Up to 1,400 and more with fewer teams.
Will stand at least.	50 motor trucks; probably more.			
But will crumble and perhaps fail with over	100	50 on narrow tires. (loaded farm wagons, ice and wood teams, etc.)	......	......
Water bound macadam with a good surface coating of tar will stand with.	30 to 50	25 to 30	10 to 15	1,800

*Perhaps more.

facing with a three-inch bituminous macadam top the extra cost for such top has varied from 30 to 60 cents a square yard, depending on material and methods used, etc., etc.

Traffic the Important Factor

I have given these illustrations and tentative conclusions merely in an attempt to show how the traffic affects the roads—how its class, character and volume, both present and future, must determine the materials to be used

and the method of their use if we road builders are to succeed in our purpose of economically building and maintaining good roads.

PRESIDENT LEWIS: I told you that this was a subject the importance of which has never been appreciated. I venture to predict that Col. Sohier's presentation will direct the attention of yourselves and others to it as it has not been directed before. The discussion of this subject is to be opened by Arthur H. Blanchard, Professor of Highway Engineering, Columbia University.

ARTHUR H. BLANCHARD (Professor of Highway Engineering, Columbia University, New York City): The continuation by the Massachusetts Highway Commission of the work started in 1909 by the taking of another comprehensive traffic census in 1912 is certainly commendable. Col. Sohier, by his able and lucid presentation of the value of the traffic census in the economical and efficient design of highways, has materially raised the status of highway engineering and thereby deserves the gratitude of this association and of all interested in highway improvement in America. This discussion cannot be other than commendatory, as the general opinions expressed are thoroughly acquiesced in by the speaker.

The value of the traffic census taken preliminary to construction is intimately connected with traffic censuses taken after the highway is built. The traffic census taken after the road or pavement is open to traffic gives the information upon which to base the design, having in mind the traffic to which the highway will be subjected. The necessity for such practice is based upon the multiplicity of types of roads and pavements which are in common use today, and the great variety of effects produced by the different classes of traffic which pass over a highway under various conditions.

The traffic census preliminary to construction gives information relative to local traffic, and, if the highway in question is a link between improved sections, data relative to through traffic may be obtained. In the investigation of the probable traffic, it is found that a careful consideration of all the surrounding highways and the relationship of each to the highway system is necessary. If the traffic census has been taken on these highways, deductions may

be made relative to the increase in traffic due to the construction of the highway under consideration. The improving of highways invariably results in an increased amount of traffic, and in most cases increased loads to be carried. In some cases such improvement means the attraction of all classes of commercial motors. In other cases the change will be in the line of the use of high speed motor traffic. It is surprising how accurate and valuable deductions relative to future traffic may be made, if the engineers have at hand such data as has been obtained by the Massachusetts Highway Commission.

Traffic data, actual and estimated, in many cases, is of vital import in designing certain component parts of a highway, such as width, foundation and wearing surface. Traffic data will also provide considerable information relative to the method of maintenance which should be adopted.

It is believed that with a more intimate knowledge of traffic and the data secured by the traffic census, the width of the metaled surface or pavement of highways, in the northeastern states at least, will be increased over the present practice. In place of the common assumption of 6 to 8 ft. for a single line of traffic, 9 and 10 ft. will be substituted so that many trunk highways of our eastern states will be 20 ft. in width, instead of 14 or 16 ft. It is of interest to note in this connection that the width of many of the main county roads of England is 20 ft., while that of the main trunk highways of France is about 23 ft.

That the design of the foundation of the road or pavement should include a careful consideration of the traffic is self-evident. Tonnage in this case is of the utmost importance. Increase in tonnage, due to increased commercial traffic, will in many cases necessitate much stronger foundations than are now being built. Either cement concrete foundations, or thoroughly compacted broken stone foundations of from 7 to 10 ins., will have to be built in place of the 4-in. foundations used in many parts of the country. This phase of the problem is causing grave concern in England at present where many requests are being made to the Road Board for grants to build up the foundations of the main county roads.

Due to the many different types of construction and the large variety of materials employed in the construction of wearing surfaces, the nature and amount of the traffic are

of vital import. In the design of the wearing surface the following factors have been found of value:

(1) Differentiation between horse-drawn vehicle traffic and motor car traffic.

(2) Division of each of these classes of traffic into pleasure and commercial traffic.

(3) Subdivision of commercial traffic into loaded and unloaded vehicles.

(4) Determination of the weight per lin. in. of width of tire of all types of commercial traffic.

(5) Subdivision of the two classes of horse-drawn vehicle traffic, dependent upon the number of horses.

(6) Subdivision of pleasure motor car traffic upon the basis of weight and speed, since in many instances the greatest damage to certain types of roads is caused by 7-seat touring cars, limousines, or landaulets, traveling at speeds of 40 to 60 miles an hour.

(7) Extraordinary character of local traffic; for example traction engines hauling trailers, motor bus traffic, ice wagons, mill drays, etc.

It is believed that grave danger is incurred if it is attempted to base the design of a highway outside of a built-up district upon a mere record of tonnage per unit of width per annum, or to use exclusively the sum of the products resulting from weighting different classes of traffic. It should not be inferred from the above, however, that the use of some common unit or units in which to express all classes of traffic, for the summation of totals and a general comparison of the traffic on different highways in different localities is not favored. In cities it is evident that the tonnage life of various roads and pavements is of great value. For example, Mr. John A. Brodie, the City Engineer of Liverpool, in 1910 used, as a basis for the comparison of different kinds of roads and pavements subjected to the same kinds of traffic, the tonnage per yard of width. He expressed the life of a granite block pavement as 7,500,000 tons per yard of width, of a bituminous macadam pavement—that is, one constructed by the penetration method—as 750,000 tons, and of water bound macadam, 100,000. However, to base the economical use of a macadam road, for instance, upon a knowledge of tonnage alone would not be sufficient in most cases.

As illustrative of some of the effects produced by dif-

ferent classes of traffic on roads and pavements of various types, the following examples are cited:

The first case is that of a water bound macadam road, located in an isolated district, and subjected to a traffic of 150 motor cars and 50 horse-drawn vehicles per day. The motor cars consisted of heavy touring cars which traveled at speeds of 30 to 50 miles an hour. Within six months after construction, the wearing surface had disintegrated to such an extent that the cost of reconstruction amounted to practically $1,000 per mile. It is self-evident that if a macadam surface on a residential street in a city had been subjected to this amount of traffic, moving at a speed of not greater than 20 miles an hour, very little disintegration would have taken place.

The second example is that of a macadam road constructed of shale rock and finished with a bituminous surface in connection with which a heavy asphaltic oil was used. The road was subjected to a large amount of motor car traffic during the summer months and during this period gave entire satisfaction. In winter, however, the traffic included heavy horse-drawn vehicles used for hauling logs. As the horses were equipped with sharp calks, the effect of drawing heavy loads upon the above surface was disastrous. The road in the spring was full of holes, some of which were 12 ins. in depth. The above emphasizes the value of taking a traffic census at different seasons of the year and also the value of a thorough investigation of the character of the traffic by consultation with the various interests using the highway.

As the third illustration will be cited the case of a bituminous concrete pavement subjected to a total traffic varying from 500 to 1,000 vehicles per day, the horse-drawn vehicles and motor cars being about equal in number. The bituminous cement used in the mix was a coal tar. The pavement was not furnished with a seal coat. The result of winter traffic for five months was the disintegration of the surface, consisting in the formation of many potholes. An adjacent section on which a seal coat was used was in excellent condition at that time. The disintegration in the above instance was due entirely to the horse-drawn vehicle traffic as the blows from the horses' hoofs loosened the individual stones in the open mosaic surface of the pavement.

The fourth example is that of a water bound macadam road built of trap rock, which highway was subjected to a daily traffic of 50 motor cars and 100 horse-drawn vehicles. This road raveled continuously during dry spells to the insufficiency of the dust, formed by abrasion, which was required to bond the road. On the other hand, a macadam road, similarly constructed, subjected to 25 motor cars and 225 horse-drawn vehicles per day, remained in an excellent condition. Of the 225 horse-drawn vehicles, 150 were commercial vehicles, which naturally tended to produce a certain amount of dust by abrasion and to continually compact the surface.

The last illustration to be cited is that of a water bound macadam road upon which was constructed a mat surface formed by using a heavy asphaltic oil and stone chips. Under a traffic of 300 horse-drawn vehicles and 400 motor cars per day, the mat surface crept, forming a wavy surface. Many holes developed caused by the blows of horses' hoofs on the mat surface.

It is evident from the above illustrations that it is essential to keep accurate traffic records after the construction of roads and pavements in order to have at hand complete data upon which to base the design of wearing surfaces of highways to be constructed under similar conditions.

A. R. HIRST (State Highway Engineer of Wisconsin): Mr. President:—It is rather discouraging to a man who faces the construction of 1,500 different pieces of road next year, and who does not know until January 1st what road he is going to construct, to hear some of the requirements necessary before we can start construction. Mr. Shirley made a remark yesterday as to the settlement of disputes between contractors and engineers which I believe applies quite thoroughly to the matter we are discussing—the type of pavement and the width of pavement. I believe these things will have to be settled in an ordinary state not from the data given by a traffic census so much as from the data given by local knowledge and common sense.

I do not know whether other engineers differ from me or not, but by a simple examination of the road and some knowledge of the local circumstances, and of the local traffic, I believe that it is entirely possible to make a very

reasonable guess as to the type of pavement and width required. If it isn't possible, we are going to have a number of monumental failures in Wisconsin. We have adopted for use in Wisconsin, in general, three types of pavements. For light traveled roads—I am prone to acknowledge that we are a little indefinite as to where light travel ends and heavier travel commences—for light traveled roads we have found a gravel road, or water bound macadam road an adequate and economical type, owing to the fact that we can build gravel roads for 30 cts. per sq. yd. and macadam roads for 50 cts. per sq. yd.; which facts have a considerable influence upon our selection. When we get to a place where we know from what we see of the traffic and effects of traffic that a water bound macadam or a gravel road is going to be a failure, we expect to maintain them with a bituminous surface treatment, and I believe we can tell mighty closely when that is going to be necessary without a traffic census. Where the water bound macadam maintained with a surface treatment is bound to fail—which can usually also be told by a knowledge of local conditions—we expect to build a concrete road or a brick pavement; and I think in nine cases out of ten when we take into account the local knowledge of the engineer in each country, we will be able to hit it correctly.

As to the width of our roads, we are building a very narrow type of road, 9 ft. surface with 24 ft. between the ditches. The average cost for macadam roads is about \$3,000 a mile, and for gravel roads is about \$1,800 a mile; and I rather wish for the sake of those of us who live west of the Allegheny Mountains that the case of the less settled states had been a little more considered in these discussions. We have in Wisconsin 71 counties, about ten of which are practically as large as the state of Rhode Island. We have in the state about 70,000 miles of road, about 12,000 of which we expect to have to improve. So that we have quite a problem, and we must build them as cheaply as possible to get service. Even then it is going to take a good many years and many millions of dollars to complete our system.

It may be to the point to state that we have about \$2,500,000 worth of construction next year, and that we have an engineering appropriation of \$40,000 to cover the cost

of preparation of the plans and the supervision of the construction so that taking any traffic census is impracticable.

RAYMOND BECK (Chief, Touring Bureau of the B. F. Goodrich Co., Akron, O.): Mr. President, just a five-minute comment from the automobile standpoint of touring. While this congress is devoted to the technique of road construction, maintenance and efficiency of service, we have lost sight of a very prime factor of preliminary consideration or in planning road building, and that is interstate travel and interstate cooperation.

PRESIDENT LEWIS: I will have to ask you to confine yourself to the subject of traffic census or wait until the program for the session is completed, when, if there is time, your paper may be presented.

DELEGATE: There is one question I would like to ask: What is the relative power of destruction of the automobile as compared with heavy teams?

PRESIDENT LEWIS: Is anybody prepared to answer that question specifically? If so we would all be glad to have it. The chair hears no answer. I am sorry, sir.

Most of you doubtless think of New York as a great city, that has few of the problems which confront many of our states. There is, however, in the city one large borough, 130 square miles in area or 40 per cent. of the entire city, which is essentially rural in character. It used to be said not long ago that a motor car might go through the state and encounter no bad roads until it reached the city of New York. I do not think that is true any longer. The title of this next paper is, "The Laying of One Hundred and Two Miles of Smooth Road Surface in One Borough in Five Months." The mere task of laying one hundred and two miles of smooth road surface in five months was deemed worthy of description at this convention. Let me introduce Mr. G. Howland Leavitt, Superintendent of Highways, Borough of Queens, New York City.

G. HOWLAND LEAVITT (Superintendent of Highways, Borough of Queens, New York City): Mr. Chairman, I want to give a little idea of traffic to the gentleman from Massachusetts, before I read my paper. We have 10,000 automobiles go over the Queensboro Bridge on any fair Saturday and Sunday. I mean 10,000 each day of

24 hours. We have in our borough, and in the adjacent borough of Brooklyn fifteen cemeteries where there are over 8,000 to 9,000 carriages a day that use our roads. Most of them come by Queensboro Bridge, others through Brooklyn. We not only have a heavy traffic of automobiles in the day time, but also during the night. There is a continuous congestion on these highways within six to ten miles of the bridge; very large traffic during the night. I took occasion lately to measure an auto truck belonging to the Import Lumber Company at Long Island City. It was 20½ ft. long with a trailer. It had on nine sticks of Georgia pine 2½ sq. ft. in cross section and 18 ft. long. The trailer had iron tires 5 ins. wide, and the combined weight was 20¾ tons. Now, that is something you will see every day in our borough with motor trucks.

THE LAYING OF ONE HUNDRED AND TWO MILES OF SMOOTH ROAD SURFACE IN ONE BOROUGH IN FIVE MONTHS

BY G. HOWLAND LEAVITT

Superintendent of Highways, Borough of Queens, New York City

A few weeks ago your President, Mr. Lewis, invited me to outline to you a part of the work carried out in the Borough of Queens, New York City, during 1912, known to us as the repaving of city highways. I shall confine my remarks to the highways resurfaced under contract amounting to 102 miles and involving a total expenditure of $1,877,820. In passing I wish to mention that the Highway Bureau employed a supervisory and working force of 612 men on maintenance, this being entirely independent of the above; and that the engineering division of the bureau, more particularly outlined elsewhere, planned, supervised and inspected assessable highway improvements amounting to $650,000, in addition to the work herein described.

We were told in the month of April of this year, while the necessary authorizations for this work were still unsettled, that it would be a physical impossibility for us to do so much additional work during the 1912 working season; if I am not mistaken, your worthy president was one of those holding and expressing such an opinion.

Consequently, now that we have carried out all of this work, or practically so, he expresses surprise at its accomplishment, and in so stating to me, thought a description of the work would be of interest to this convention. The bulk of this work was carried out during the last four months at an average rate of 10,000 sq. yds. daily, or practically one mile a day.

The Geographical Layout

Queens Borough is a portion of the City of New York. It contains within its borders 40 per cent. of the entire area of the greater city. Its broad acres extend northerly and southerly from the East River (Manhattan) to and including the finest summer resorts of the Atlantic Ocean, and easterly and westerly from the thickly built up portions of Brooklyn to Nassau County—an extensive playground and breathing place for the inhabitants of this greater city. It has a population of 285,000, equal to that of either of the following cities: Jersey City, Kansas City or Seattle. The north and south dimension of the borough, from the East River, or from Long Island Sound, to the ocean is 16 miles, and from the east to west the distance is 14 miles. The population is grouped along water fronts and transportation lines, leaving wide intervening stretches undeveloped. The highway improvements, which are the special matter discussed in this paper, form a network of main arteries of travel connecting centers of population and interest within the county, and form main highways through the county from the thickly settled portions of the greater city to the summer resorts on the Atlantic and the rest of Long Island. The census of traffic on the main arteries leading from the Queensboro Bridge and on the main extensions easterly of the highways of Brooklyn, indicate a mixed travel per foot of width of paved area, equal in density to that of many of the streets in the built-up business sections of our great city.

The Problem in 1912

At the time of consolidation in 1898, Queens County, coterminous with the borough, had 450 miles of water bound macadam. During the 14 years that have passed, insufficient provision of material for their proper maintenance, poor organization, and neglect, combined

resulted in a condition of these highways that made general repaving an urgent necessity. In fact, it was this condition of these highways that prompted us of the incoming administration in planning so extensive an improvement to be carried out in a single season, and it was undoubtedly this also that made it possible for us to obtain so large an amount of money for such an unusual proposition. The necessary authorizations and appropriations were obtained from the Board of Estimate and Apportionment during April, May and June, 1912. It is customary for the City of New York to assume the responsibility of keeping in good condition the paving on all streets once paved and paid for by assessment. These particular highways were not paved originally by assessment, but because of the necessity of a repaving and because of the importance of these highways to the greater city as main arteries of travel, this work was authorized by making 15 per cent. of the cost a direct charge upon the county and 85 per cent. upon the greater city.

The old macadam roads generally had good foundations, many of them, in fact, having a telford bottom, and with few exceptions the grades are light and the drainage good, the subsoil being sandy. In a few instances the grades ran between 5 and 8 per cent., which portions received special attention.

Character of the Repaving

The controlling features in deciding upon the character of paving to be used were: The nature of the traffic; the construction then in place, which was to be used to best advantage; the first cost, and the cost of maintenance. Probably 75 per cent. of the traffic is automobile, on pleasure or business bent. This portion of the traffic demanded a smooth pavement and one that could be kept in smooth condition continuously. The heavy horse-drawn traffic demanded a surface affording a good foothold and easy draft. For heavy grades the choice was granite block. Generally a bitulithic carpet placed upon the old macadam seemed best to meet all requirements and conditions. The first cost of a bitulithic macadam (pentration method) would have been considerably lower than a bitulithic concrete (mixed method). Under the traffic to which these roads are subjected a light flush

coat of bitumen and stone at a cost of from 10 to 15 cts. per sq. yd. would be necessary yearly to maintain a bitulithic macadam in good condition. Experience has demonstrated to us that such is the case. Adding this to first cost (as determined by actual contract costs) would bring the cost at the end of five years to about $1.25 per sq. yd. for bitulithic macadam. We estimated that a bitulithic concrete on a properly prepared macadam foundation, including the preparation of the foundation and 5 years' guarantee, would not exceed this. The low bids as received have varied generally from $1.00 to $1.20 and the average for 1,396,550 sq. yds. is $1.11, including a 5 years' maintenance.

Owing to differences in the length of haul for materials used and also in the varying requirements as to gutters, binders, etc., the price bid varied in the different contracts. In the case of the Hoffman Boulevard, a street of unusually heavy traffic, the price ran as high as $1.44 per sq. yd., while on the other hand there were a number of cases in which prices ran below $1.00, going as low as 86 to 91 cts. in several cases.

The essential features of these specifications for a bitulithic concrete wearing surface are the requirements for the asphalt, mineral aggregate, the method of preparing the old macadam foundation, and the laying of the asphaltic concrete. A high grade of asphalt was specified and materials from five different sources were used by the various contractors. About three-fourths of the entire amount used, however, was Bermudez asphalt.

A trap rock and sand mineral aggregate, ranging from ½ in. to dust, well graded as to size, was specified. Minimum and maximum limits for percentage of asphalt 200, 40, 10, ¼ and ½ mesh mineral aggregate were specified before mixing; however trial tests were run within these limits with material on hand with the object in view of determining the densest pavement possible thereunder. The trap rock screenings as delivered in the New York market with two grades of sand and stone dust were required to make up a suitable mixture.

The city maintained inspectors at each of the plants continuously while mixing. These inspectors were required to take samples of the mineral aggregate, as mixed, at least four times daily and run the samples over the

screens to determine whether the proper mixture, at which we were aiming within these limits, was being obtained, to see that the required amount of asphalt was placed in the mix and that the temperatures of the stone before mixing and the mixed material as prepared for the road were correct. They were required to make daily reports to the main office by mail each night. The asphaltic cement as prepared for use was tested every other day at the municipal standard testing laboratory.

Preparing the Foundation

The old macadam road was as lightly scarified as would permit of the reshaping of the old road to the crown desired. After shaping with rakes and forks, it was then rolled and filled, additional stone being added where necessary, until the foundation was tight and compacted, to a width 1 ft. wider than the finished pavement. Two-inch planks were then drift bolted to the foundation, along the lines to which the asphalt was to be laid and the asphalt spread and raked. In rolling, the rear roll was to run over these planks so as to grip them, and in this way good compression was obtained on the edges; neat cement was cast over the surface and the preliminary rolling and swept with a broom so as to fill in the small voids in the surface and the rolling continued to final compression. After the removal of the planks, the macadam along the edges was partly removed and bricks, generally in three courses, laid along the edge and filled with a bitulithic filler. In some instances the bricks were omitted and broken stone was used along the edges, filled with screenings and thoroughly rolled in. This latter method seems to prove satisfactory where the travel is not crowded so as to compel vehicles to run along the edge of the pavement constantly. The wings of the roads were then graded to a gutter line generally from 5 to 7 ft. from the edge of the pavement.

Although the seepage into the subsoil, as before mentioned, is good, there were places where water would collect, and we took special pains to drain these places by building small basins with drains to carry off the water. Stone gutters were used wherever it was deemed advisable to prevent wash.

This work was pretty evenly distributed over an area

of 65,000 acres, and I will now try to give you an idea of the city's organization in charge of this work.

The President of the Borough is the elective head of the borough government, and as such, a member of the Board of Estimate and Apportionment. The most important of a number of governmental functions placed under his control, is that of the construction and maintenance of the highways. The Superintendent of Highways is the member of the president's cabinet in direct charge of this branch of the borough government. The Consulting Engineer is the direct head of all engineering work of the borough, with an engineer in charge of each of the following divisions, viz.: Highways, sewers and topographical. The Engineer of Highways reports directly to the Superintendent of Highways on administrative matters and to the Consulting Engineer on engineering matters. He has four assistants in charge of divisions of the work; one of these assistants is in charge of the office force and the other three have charge of all construction in their respective sections of the borough. There was a total of 78 engineers, rodmen, axemen and inspectors on all work in the borough during 1912.

The making of preliminary estimates and the preparing of the specifications and plans, and all executive work in carrying out the construction herein described, were taken care of by an office force which was pretty fully employed on other work. It is needless to say that many of the regular assessment proceedings were delayed, and that it was impossible to give the time and necessary care to satisfactorily prepare so large an undertaking in all its details. Generally from four to six weeks intervene between the authorization of an improvement and the registration of the contract by the Finance Department, upon which official act it is possible to order ahead a contractor on the work upon which he bid successfully. Our procedure requires 11 distinct official actions, by the president of the borough, corporation counsel, comptroller, city record and the contractor in the aforementioned procedure. These contracts were invariably put through in record time, in many instances cutting the usual time in two and even less, by a following up process that did not permit of any delay or any inactive intervening periods. I wish to express at this time and place my

appreciation of the commendable dispositions of our contractors in helping along these preliminary proceedings. They entered into the work with a zest, even in these preliminaries, thus making it possible for us to reach the constructive period quickly, and furthermore, upon being awarded the contracts, they immediately anticipated an early constructive period and started in to organize their working forces, erect plants and obtain supplies, so as to be ready for action at short notice. Owing to the fact that there was an unusual amount of paving work in the greater city during the 1912 period, it was at times impossible for the contractors to get their deliveries of material as quickly and as regularly as they would have desired. At times the transportation facilities, especially those at the river front for the unloading of material from boats into cars of the Long Island Railroad, were taxed to the limit. The entire work was divided into 57 contracts for which bids were received. The greatest length covered by a single contract was 6.2 miles, the shortest .47 mile. In every case the contracts were allotted to the lowest bidder, and this resulted in the distribution among 17 contractors, as shown in the table. [See next page.]

All the asphaltic concrete contracts were identical as to form, and there was a single standard set of specifications throughout, which, however, provided sufficient elasticity to be adaptable to any conditions of the old roads.

Field Organization

The division engineers in the field were almost overwhelmed with supervisory work. These men had to travel a distance varying at different periods of from 70 to 90 miles daily to visit each point of construction once during the day. It was only by the use of automobiles, which were constantly at their disposal, that they were able to cover the work, and had it been anticipated that succeeding years would bring forth a similar amount of work, it would have been advisable to extend this organization along permanent lines, a thing not readily or quickly accomplished under our civil service and budgetary regulations. The inspectors, 40 in number, took their instructions and assignments directly from the division engineers and reported daily to the main office by mail.

It was largely through these reports that the main office kept in close touch with the work.

Contractors' Plants

Portable plants of several different types, but working on the same principle as the permanent asphalt plants, were used in carrying out this work, in addition to the

TABLE SHOWING DISTRIBUTION OF CONTRACTS

	No. of Contracts.	Total Mileage.
ASPHALTIC CONCRETE PAVEMENT.		
Contractor No. 1	11	34.51
" " 2	7	18.26
" " 3	4	10.73
" " 4	2	7.10
" " 5	3	7.00
" " 6	4	4.70
" " 7	1	2.91
" " 8	1	2.10
" " 9	1	2.00
Total		89.31
SHEET ASPHALT PAVEMENT.		
Contractor No. 2	2	0.83
" " 4	2	0.60
" " 6	1	0.40
Total		1.83
WOOD BLOCK PAVEMENT.		
Contractor No. 10	1	0.68
ASPHALT BLOCK.		
Contractor No. 11	11	3.25
GRANITE BLOCK PAVEMENT.		
Contractor No. 12	1	2.46
" " 13	1	1.63
" " 14	1	0.83
" " 15	1	0.80
" " 16	1	0.78
" " 17	1	0.43
Total		6.93

RECAPITULATION.

89.31	miles of asphaltic concrete pavement.
6.93	" " improved granite block pavement.
3.25	" " asphalt block pavement.
1.83	" " sheet asphalt pavement.
0.68	" " wood block pavement.
102.00	miles.

three permanent asphalt plants belonging to local contractors which were partly engaged upon the work. Contractor No. 5 used a plant technically known as a semi-portable plant, consisting of high speed engine and locomotive boiler; sand heating devices consisting of a drier

30 ft. long and 4 ft. in diameter jacketed with asbestos, equipped with a dutch oven with fuel oil burner attachments; a mixing unit consisting of an inclosed hot sand bucket elevator, sand screens, sand hoppers with the necessary bins for the separation of the mineral aggregate, measuring boxes, and a 9-ft. asphalt mixer. The usual asphalt kettles of about 1,000 gals. capacity were used. In this particular plant fuel oil was used both in the heating drum and in the boiler with excellent results. This plant had a maximum capacity of about 1,500 sq. yds. of 2-in. asphalt concrete per 8-hour working day.

Contractor No. 6 on a portion of the work used a semi-portable plant very much of the same type as the one above described. This plant, as well as several others, was equipped with the necessary compressed air fixtures to convey the asphaltic cement from the tanks directly to the mixing platform. This plant would prepare and mix enough bituminous macadam mixture to lay 1,200 sq. yds. 2 ins. thick in 8 hours' operation. The other plant used by this contractor was a permanent asphalt plant with a capacity of about 3,400 sq. yds.

Contractor No. 8 put up a permanent plant on the water front in the borough for use in his work throughout the city. This plant has a capacity of about 3,000 sq. yds. of 2-in. asphaltic concrete per working day of 8 hours. This plant was equipped with a compressed air purveyor for the asphaltic cement.

Contractor No. 3 used two railroad plants, each having a rated capacity of 2,000 sq. yds. These plants are mounted on railroad trucks and so constructed that they can be dismantled and made to travel on their own wheels when in transit. They are provided with horizontal revolving drums mounted over a fire box and surrounded with a fireproof arch through which the mineral aggregate is fed. These plants weigh about 90 tons each and they have their melting kettles, mixing apparatus, boilers, engines and shafts so arranged as to enable one to readily prepare the same for transit or for operation after transit. This company carried a fully equipped laboratory and employed experienced chemists at the plant to supervise tests and analyze its mixes and pavements.

Contractor No. 1 used six portable asphalt plants in carrying out his portion of the work. The plants are

conveniently arranged for shipping and are substantially constructed, and set on their own wheels for transportation from one place to another. One of the main favorable features of these plants is the fact that they can be put in operation in new locations in a few hours; although simple in their construction, they are so arranged that there is no guess work as to the proportions of the ingredients, but every step and every portion is under direct control of the operator.

There were 14 plants engaged on this work during the season, and the main features of the others were similar to those above outlined, or a combination of the same. The plant used by Contractor No. 7 differed from all the rest in that the mineral aggregate was put directly into the mixing drum and heated by a hot air blower and then the asphaltic cement was supplied by an air compressor directly from a measuring tank, the stone dust added and the heating and mixing continued until the proper temperature was reached. This plant weighed 36 tons and could be moved readily. It worked very satisfactorily and had an average capacity of 1,000 sq. yds. of 2-in. asphaltic concrete in an 8-hour run; in some instances this amount was exceeded by several hundred yards.

Contractor No. 4 mixed the material in a permanent plant located on Newtown Creek in the Borough of Brooklyn, whose capacity is 4,000 sq. yds. of 2-in. material in a run of 8 hours. This plant is probably as complete and well arranged as there is to be found, it being practically dustless when in full operation, and after the first elevation of the material, the whole operation is by gravity. All material is under cover and kept from the weather from the time it is unloaded from the scows until it is sent out as a finished product. The material is removed from the scows into a cubical reception bin of 36 ft. dimension, capacity 1,728 cu. yds. From this bin the material is elevated by belt and bucket elevators to bins from which it is conducted into two driers 5 ft. in diameter and 35 ft. long, motor-driven and heated by oil. No screening is done in the driers, all material being screened before it reaches them by screens 10 ft. long and 30 ins. in diameter. The material which does not pass the screens is shot into what is called a binder bin. The hot sand boxes supplying the mixers are 30 ft. long, 10 ft.

wide and 10 ft. deep. The dust is stored on the third floor and is added to the mixture by means of tightly enclosed chutes. At the mixing box there are two openings for stone and five openings for sand, admitting of the control of temperature and grading. All mineral aggregate is weighed at this point before being dumped into the mixer. The mixer is entirely enclosed, leaving no openings for the escape of the dust. The asphaltic cement is heated in four tanks of the usual type, two of which are used as melting tanks only and two as working tanks; they are supplied with air agitators. The machinery is driven electrically and an oil engine is always ready to carry on the work in case of an electric breakdown.

Contractor No. 2 carried out the work from a permanent plant of the usual type located on Newtown Creek in Brooklyn. This plant was located from 6 to 12 miles distant from the site of the work, the material was brought in trolley freight cars to a switch near the work, from which it was then trucked to the street and in some instances, where a trolley track was on the street, the material was shoveled directly from the cars into the place to be paved. This plant has a capacity of 4,000 sq. yds. of 2-in. material in an 8-hour working day and the highest run for a single day of 8 hours was 3,500 sq. yds.

Progress of the Work

The asphalt work was divided into 50 contracts. There were 10 contractors successful in their bidding, using, all told, 14 different plants during the season. There were over 2,000 men of all classes engaged in this work, and on Oct. 15, 1912, the various contractors employed 1,585 men. Contractor No. 1 laid 6,867 sq. yds. of bitulithic pavement on Oct. 15, 1912, in addition to fixing an equal area of macadam foundation and the laying of brick binder and stone gutters, and other incidental work in cleaning up. On Oct. 15, 16 and 17, the contractor in a 3-day run averaged 6,745 sq. yds. of bitulithic pavement daily with a force of 722 men employed, this number including engineers, foremen, laborers, etc., employed on the various portions of the work. The contractor contracted all told for 330,000 sq. yds., or about one-third of the asphalt work, all of which has been completed since July 18,

1912. This contractor used 1,500,000 bricks for edges and about 1,000,000 granite blocks for paving on hills and laying gutters.

Contractor No. 6 on a 10-day run averaged 2,520 sq. yds. daily, with a run of 3,000 sq. yds. for a single day.

Contractor No. 8 had a high run of 2,117 sq. yds. for a single day and an average daily run for six consecutive days of 1,483 sq. yds. This company used automobile trucks in the delivery of the asphalt with uniform success. The automobile truck has an especial advantage on a foundation of this kind over the horse-drawn truck, in that the foundation is undisturbed in dumping.

Contractor No. 3 had a high run of 2,098 sq. yds. and an average daily run for 6 consecutive days of 1,900 sq. yds. This contractor used automobile trucks successfully in the delivery of the broken stone for foundation, the brick and other materials used along the line of the work, but did not, however, use the automobile truck in the delivery of the hot asphalt.

Contractor No. 5 had a daily average for 4 consecutive days from the portable plant of 1,000 sq. yds.

Contractor No. 4 had a high run of 3,320 sq. yds., and an average record of 2,500 sq. yds. a day for 31 consecutive working days.

It may be of interest to note the combined estimated contract cost of all the asphaltic concrete work as above described amounted to $1,479,117.35, and that the aggregate cost appearing in the final certificates will show, probably, a saving of some $87,000.00, a difference of less than 6 per cent.

PRESIDENT LEWIS: Gentlemen, this paper was essentially descriptive. No one was asked to present a formal discussion, but I am sure Mr. Leavitt will gladly answer any questions which you want to put to him.

MR. ROGERS: I would like to ask if this type of construction is considered to interfere in any way with the patents of the Warren Bros. Co., or if there was a royalty paid?

MR. LEAVITT: The roads were built under what is generally known as the Topeka specification, which does not conflict with that patent.

MR. REEL: Before adjourning could we not hear from

the gentleman who wants to read a paper from the automobile point of view?

PRESIDENT LEWIS: Let me ask Mr. Beck if his paper could not be considered germaine to the subject which was up for discussion on the afternoon of the first day of the convention, namely, the "Development of a Plan for a State Road System?" If so, and if there is no objection, I see no reason why it should not be presented now and printed under that discussion.

MR. BECK: Not being here in time to present these notes under the proper subject at the proper time, I had an idea that it might come in properly during the discussion here this afternoon. I will be glad to read it.

[This paper is printed in the proceedings of the third session as a part of the discussion on the paper, "The Development of a State Highway System," by Jas. R. Marker, State Highway Commissioner of Ohio.]

Meeting of The American Road Builders' Association

The meeting of the American Road Builders' Association was called to order by President Nelson P. Lewis at about 5 p. m., Thursday afternoon, December 5, immediately after the adjournment of the sixth session of the association's ninth annual convention.

The first matter taken up by the meeting was the consideration of communications relative to the holding of the next annual convention. The first invitation came from the city of Washington, D. C., and was presented by L. R. Grabill, Superintendent of County Roads of the District of Columbia, who read a letter from the Washington Board of Trade and another from the Washington Chamber of Commerce extending invitations for the holding of the 1913 convention in that city. In addition, Mr. Grabill spoke briefly of the advantages of Washington and the District of Columbia for the purpose.

President Lewis also read two telegrams of invitation from Chicago, one from the Association of Commerce inviting the American Road Builders' Association to meet in that city in 1913 and the other from Mayor Carter H.

Harrison referring to the communication from the commercial organization and adding his own invitation as mayor.

The third invitation came from Dallas, Texas, in a telegram from the Chamber of Commerce, which was read by the President.

President Lewis stated that, following the usual practice, these invitations would be referred to the Board of Directors, with power to act, unless the meeting should direct other procedure. No objection to this being made, the invitations were so disposed of.

Harold Parker, Chairman of the Committee on Resolutions, then presented the report of that committee, which embodied two resolutions as follows:

In acknowledgment of the assistance so freely given by the Governor of the State of Ohio, representing the people as a whole; the county officials, representing the counties; the Mayor and city officials of Cincinnati, representing the business men of Cincinnati; the State Department of Highways, representing the art and science in which the members of this Association are most seriously interested; the United States Office of Public Roads, representing the Federal Government; the State University of Ohio; the University of Cincinnati, O; the press; the states, cities and educational institutions which have contributed to the success of this congress; and all exhibitors who have by their efforts made the exhibition the largest and most complete of any congress held in this or any other country; It Is Resolved That:

The American Road Builders' Assocation appreciates the assistance and cooperation of each and every one, and that to each and all the sincere thanks of the Association are extended.

The American Road Builders' Association, in the ninth annual convention assembled, hereby declares its unqualified support of the appointment of a committee by the President of the United States, consisting of experts in the construction and maintenance of highways and the relative material requirements of different sections of the United States, to investigate and report upon the advisability of establishing a system of national highways.

On a motion made and duly seconded, a vote was taken on the acceptance of the report of the Committee on Resolutions, and it was unanimously voted to accept it as presented.

Harold Parker then moved the selection of a nominating committee consisting of John R. Rablin, Chief Engineer of

the Metropolitan Park Commission, Boston, Mass.; Jos. W. Hunter, Deputy State Highway Commissioner of Pennsylvania; Henry G. Shirley, Chief Engineer of the Maryland State Roads Commission; Robert C. Terrell, Commissioner of Public Roads of Kentucky, and Geo. W. Cooley, State Engineer of Minnesota. The motion was seconded and carried unanimously, after which the meeting adjourned.

Evening Meeting

This meeting was held on the evening of Thursday, December 5, in the auditorium of Music Hall, the building in which the convention and exhibition were held, and was attended by a number of the delegates and guests.

The lectures were three in number and were devoted to brick pavements, wood block pavements and concrete roads. The first, on brick pavements, was delivered by Will P. Blair, of Cleveland, Ohio, Secretary of the National Paving Brick Manufacturers' Association, who explained the methods of building pavements of brick, and set forth the advantages of that type of pavement. The lecture was illustrated by stereopticon views of roads before and after paving with brick and of brick roads in process of construction. The second lecture was on wood block pavements and was given by Geo. W. Warmoth, Indianapolis, Ind., of the American Association of Creosoted Wood Paving Manufacturers. This lecture, like that on brick pavements, was illustrated by lantern slides showing both incorrect and correct methods of construction and a number of views of wood block pavements in various parts of the country. The third lecture, that on concrete road construction in Wayne County, Michigan, was delivered by J. H. Chubb, of the Universal Portland Cement Co., Chicago, Ill., and was illustrated by moving pictures showing the roads and the traffic over them before improvement, the work in progress, and completed roads.

Many of the lantern slides were colored and showed not only the roads themselves and the work of building them, but also illustrated the equipment used and the details of the work.

SEVENTH SESSION

Friday Forenoon, December 6

PRESIDENT LEWIS: Yesterday afternoon, too late to be read at the meeting, this cablegram was received: "President Lewis, Good Roads Congress, Cincinnati: Congressmen, greetings. Come all to London next June." Signed, "Rees Jeffreys." Mr. Rees Jeffreys is the general secretary for the Third International Road Congress, to be held in London next year, and he sends his greetings, and expresses the hope that you will all come to London to the big congress next June. Allow me to express the hope that the American Road Builders' Association will be well represented. I took occasion to call your attention in my address on Tuesday to the fact that of twenty-one American authors selected to prepare papers for this congress, eighteen were members of this association. With your approval I will return Mr. Jeffreys' greeting, thanking him for his interest and expressing the hope that there will be a good representation of American Road Builders at the London Congress.

Now, gentlemen, as to this morning's session, there must be some rule for orderly procedure; and with your approval this plan will be followed: Each of the three subjects which have been chosen will be allowed three-quarters of an hour. Each subject will be introduced by a speaker who will be allowed ten minutes, and if he desires, and if you consent, an additional five minutes, a total of fifteen minutes. After that the time limit for speeches will be five minutes. If those rules to govern the discussion meet with your approval, we will consider them adopted. If not, we will be glad to have you change them. You will remember that the subjects chosen were these: First choice, "Convict Labor on Road Work"; second, "Division of Expense of Road Improvement over Town or Similar Local Unit, County, State and Nation"; third, "Correction of Alignment and Grade in Existing Highways"; and fourth, "Dust Prevention." If possible we will try and consider this fourth question, which is a very important one; and I hope that some of you will be prepared to discuss it.

I beg to retire now and yield the chair to Vice President W. A. McLean, who has consented to preside at this session.

CHAIRMAN McLEAN: Mr. President and Gentlemen:—I appreciate very much the courtesy which has been extended to me in asking that I preside over this, the most important session—the most important session because it is the final, and also because it is especially your session. The subjects which you are to discuss have been especially selected by the floor of the house, and their treatment is entirely in your hands. Our organization meets in this way only once a year, and it is extremely desirable that every member should make the most of the opportunity of exchanging views. You have heard the rules which control this session, and which I understand you have agreed to. I am afraid that I will have to use freely the instrument of torture (the gavel) which is placed in my hands in order that we may get over the ground before us, and that we may give everyone an opportunity to speak.

I have much pleasure in calling upon Mr. Samuel Hill, who needs no other introduction, to open the discussion on convict labor.

CONVICT LABOR ON ROAD WORK

MR. HILL: Gentlemen, this question of convict labor to us in the West, is a very important one. It was the deciding factor in the last election held in the states of Washington and Oregon. When I began this convict labor question twelve years ago, it was almost a new question, the state of North Carolina, the state of my birth, being the only place, so far as I know, where convicts were employed on the highway exclusively for the benefit of the state. We had a few objects in view in the state of Washington, but first and foremost of all, strange as this may seem to you, it was not the building of roads, but the reformation of the convict. I began, first of all, by talking to the labor organizations. I met the labor organizations of Seattle in a room and talked to them plainly. I said:

"Now, gentlemen, the farmers control this legislature. They want roads. The roads are for your benefit in town as well as theirs in the country. If any good reason can be given by you why any man, whether rich or poor, convict or free, should be supported in idleness, I'll be very glad to hear from you."

"Well, we don't want work taken away from honest men."

"What is your business?"

"I am a plasterer."

"Did you ever build any roads?"

"No, sir."

"What do you get a day?"

"Seven dollars and fifty cents for eight hours."

"Got a pretty good thing, haven't you? Did it ever occur to you, my friends, that the farmer out there on the farm gets the same kind of a dollar that you get and works more hours? I want to tell you now, plainly, this thing is going to go through. It is going to go through for this reason: We take away the chief support of the family, we deprive that family of anything in the way of subsistence, and then we throw the burden of supporting that man and his family on the community. The whole plan is wrong and we are going to change it. Now, you had better line up and get in, because, if you don't, we will put you back on the 12-hour schedule with the farmer."

Well, we talked about it for about three hours. The labor organizations of Seattle, were, I may say, a hard class to deal with, but they saw that we meant what we said, and they indorsed the work. The first they gave us was 30 convicts. The politicians thought it would be a good thing to make a joke of us. They shipped those convicts from Walla Walla to Spokane, and from Spokane a long distance to Wenatchee, then 80 miles by boat, then walked them 25 miles. I said:

"Gentlemen, I thank you. You are very kind and very considerate. You have made it very easy for us. We accept the challenge."

We went up there and advertised for bids to build a road. The result was that we took the lowest bid as a basis for our convict labor. We had the convicts build their own stockade. I stayed with them myself, with the highway commissioner and the governor. Then we proceeded to tell them what we were going to do. We gave them all they wanted to eat, took off the stripes, took off the shackles, and didn't even cut their hair. I said:

"There are 30 of you here. This stockade was not built to keep you in. It was built to keep the other men out.

We are going to make this cut through this 2,000 ft. of rock. Do you see those men up on the hill? Those are my men; they are Tennesseeans, Kentuckians, North Carolinians—and what have they in their hands? Sticks? No; sir. Those are rifles; the men are sharpshooters. I am going to treat you like men, and you have got to treat me as a man should be treated. There is a mimeograph record here of every one of you boys, a description at every crossroads in this county, and here is my personal offer of $100 for every man they bring in dead. They will pot you like a rabbit. If I were you I would stay inside."

They decided to stay inside; it seemed a little better to stay inside. They went to work. What did they do? They built that road, and when we got through, over all expenses, including the cost of transportation, the amount they had earned, net, was $4.03 per man per day. The people saw this road built. The farmers came out through the gorge where they couldn't cross the mountains before, and they said, "For the first time in 27 years we have come out in winter time." Then, they went a little further with us; and finally we had out 500 convicts in the state of Washington. We opened five separate rock quarries, and the rock was put where it would reach the greatest number of people.

Now, I want to remove an impression that exists in some minds about what a convict is. Why, gentlemen, we have got a wrong idea about a convict. What is a convict? A man commits a crime. He is discovered, and he is sentenced to imprisonment. When that is over he comes out and goes back under another name, whereas, he is the same man. He is exactly the same as all other men. But I found out more than that; I found this, that the penitentiary is simply a great city. All it needs is organization; that is all. I have worked on the railroad grades, I have handled men in Butte, Montana, and all through the West, and I am familiar with what they can do. It was not a new problem to me. Men are the same whether convicts or free; and I knew they were not afraid of me, and I wasn't afraid of them. We went out and built another convict camp down at Lyle. What was the result? A great big, thick-necked contractor said:

"Mr. Hill, you can't do that."

I said, "You mean, you can't do that. I will take you down there and pay your wage and show you."

When we got there he said, "Mr. Hill, this is the best camp I ever saw."

"Yes," I said, "it is the best I ever saw, and I have seen thousand of them."

"Not thousands, Mr. Hill."

"I think I have. I was the president of the Manitoba Road, and I must have seen thousands of camps."

He said, "Mr. Hill, this is a remarkable camp. What do you pay your man a day to handle your dynamite."

"I pay him his board and clothes."

"What, a convict! Have they got dynamite?"

"Yes, you stick close to me and you will be all right."

"Aren't you afraid of them?"

"No, I am not afraid. If you will stick close to me you will be all right."

"I don't care if that man is a convict, he can't handle that amount of rock with that amount of powder."

"Do you know what this man is in here for?"

"No."

"This man is a professional burglar and safe blower, and he makes a little powder go a long ways." (Laughter.)

He said, "He don't waste a grain of powder, does he?"

No, he didn't.

"Why, here are remarkable tools, where do you have them sharpened?"

"It is done there at that out-door forge. They ought to be good tools, the man that sharpens them can make burglars' tools. He is an artist, he is on to his job."

"Well," he said, "this is a very interesting thing."

I said, "Yes."

We have experimented, we have found out the unit that is best to use in convict labor, and I have found out that the best unit to use is 100 convicts, if we can get them. In having all the various men to do the work around the camp, we found the best unit is 100. We found out exactly how to handle these men, what clothes to give them, how to feed them to get the best work out of them.

"Now," I said to him, "come out and have something to eat."

He said, "You don't eat with the men?"

I said, "Yes, right down here at the table."

He didn't enjoy his meal at first. Finally he said:

"This food is very good."

"Yes," I said, "it ought to be good. Don't you like the cook?"

He said, "I never saw him before."

"Oh, yes, you have. I am very fond of this cook. He used to run a big German restaurant at Tacoma. He is the best cook in the state; he saves everything he can, uses all the scraps to make a nice hash. Isn't he a bird?"

"Yes," he said, "he is." He said, "Mr. Hill, you make your men work like fiends."

"Oh, no, I don't. I don't have to."

"I can't make my men work like that."

"I don't drive them. They drive themselves."

We have, my friends, in our state, the indeterminate sentence law, the result of which is that each man tries to do the best he can. The result is this, each man tries to be the best convict of the bunch; and we have the right to pardon them. We pardoned nineteen men a short time ago. Those men went out and now they have got jobs,—and we have changed the law in that respect. They are well taken care of.

He said to me, "Who is that quiet man?"

I said, "He is a sergeant."

He said, "What do you mean by sergeant?"

"Well," I said, "Kipling said the sergeant made the army; he knows how to handle the common soldier; and incidentally this man here was out in the Philippines, engineering and building roads. He knows how. This man here happens to be a dead shot. He will shoot down a bird across the street. I always told him that if a man tried to escape and he missed him he would lose his job. And no man has tried to leave this whole camp. That is what that quiet man is here for."

"What is that noise?"

"I don't hear any noise. Oh, that noise outside, that is a kennel of bloodhounds."

"My God, look at that, will you? Let me get back to town."

Well, those men earned for fourteen months $3.95 per man per day, and did that rock work. Major H. L. Bowlby, our Highway Commissioner, was a West Pointer and a

real road builder. We allowed the same rate per man per day that was paid dollar for dollar for on the great North Bank Road for the same kind of work, and on this classification each man earned $3.95 per day.

So much for the Washington camps. Over in Oregon they have tried another plan. Governor West came over and he tried the plan of what he called honor camps. In the honor camps he puts men out, takes their word for it, takes off the shackles, takes off the stripes and lets them do the work, and does not have any guards at all. I think there is some objection to that. I don't believe you could go out on the street and pick up 100 men who had had no previous experience and no previous training and take them and make an organization and do as good work as by having a man over them. You might, perhaps, have the honor camp and have the guarded camp, and then transfer from one to the other.

Now, you must take care of the convicts, because you remember, gentlemen, society is interested most of all in the man down at the bottom. You have got to use up raw material, and your success depends on the utilization of the scraps; in any business it is the by-product that makes the business go. Now, we will have laws passed, at the next session, of this kind and character. They will provide for remuneration for those convicts on the basis of 50 cts. per man per day, and under this law that money will be taken, where they have dependent families, and given to those families to take care of them, and so relieve the community to that extent. When a man has no one depending on him, that fund will accumulate; and I want to say to you, gentlemen, there is a lot of difference between going out with $50 in your pocket and with nothing. I want to tell you that there is no phase of life I haven't tried. Gentlemen, I thank you. (Applause.)

GEORGE W. COOLEY (State Engineer of Minnesota): I want to ask a question, Mr. Hill, for general information. When a man gets through serving his time do you take that man back?

MR. HILL: Well, in this way: A man would say to me, "Now, Mr. Hill, you know all about me and my record." I would say, "Yes, sir." Now, we had there a very bad law. We had the law of the "first friend" and after a man had served his time, or was paroled, he would

go out under the parole of his first friend, and a great many times his first friend was a saloonkeeper or a dive keeper. Consequently we passed a law and made the state the man's "first friend" and made the detention camp the place where he went. We gave him employment at the same rate of wage—we knew what he did and could do.

MR. COOLEY: Did that engender jealousy?

MR. HILL: Among the men—no, sir, we have no jealousy out there.

O. J. STILWELL (Secretary, International Good Roads Association, Ogden, Utah): I would like to ask, Mr. Hill, why the convict labor work was discontinued in the state of Nevada?

MR. HILL: I can't answer for Nevada. I never campaigned Nevada. I have campaigned Georgia and Alabama. They adopted our plan in Colorado, as you know, in part, then also in the state of Oregon. I cannot tell you about Nevada. I didn't have time to go down there. Convict labor was discontinued in our state because they played politics with us. They won't again. The men that played politics are now open for a job, all of them, from the governor down.

MR. COOLEY: At the last session of the Legislature of Minnesota a bill was introduced providing for the use of trusties under a patrol system, and was adopted. I was going to ask Mr. Hill whether he had had any experience with the employment of trusties.

MR. HILL: Yes, sir, the employment of trusties is a very desirable thing. I never yet have had a case of violated confidence with the trusties that we put out to patrol the roads, either, for maintenance or for patrol. I was very much humiliated on one occasion, however. We had a trusty out looking after a big culvert which needed repairs; it had been damaged by a big rain. The time came for the stockade to be closed and the man wasn't there. I rushed out to look for him, and found him sitting there waiting for the forms to dry. He had forgotten he was a convict. I turned red and retired. Do you blame me for it?

MR. COOLEY: Another question: The proposition of using trusties on road patrol service is a matter of considerable importance, and I would like to know what

other states, Washington especially, have done in the matter of compensation for these men for work outside of their prison duties. Do you pay these men? Do you give them any allowance? Suppose you are having trusties to go out on patrol.

MR. HILL: Not at the present time. As I said, that law will be passed giving these men 50 cts. a day. Of course, we simply had the convicts, and then had the pardoned men, the paroled men, who went out and who got the regular rate, $2.50 a day at that time; 25 cts. an hour is what we pay all of these men as a regular wage as soon as they are pardoned. To answer that question and make it clear, we found that the best way to handle a railroad gang was to use 70 men. The 100 men camps we found best for convict labor. When you have your men out to work for the first three months—sometimes 45 days—the men are no good at all, just as they are in building a railroad. When they come to you they have not been fed right; they are not in shape. These men come there as bums, pickpockets and thieves, and they are not calloused and not hardened. You have got to feed and fatten them up, and when you get them in shape then they begin to do work. I venture to recommend, if I may say so, to all of you this: Have not alone convict camps, but have detention camps to take the young men to who are convicted or about to be convicted of some crime—not regular convicts, but what you may call misdemeanants. Have them sentenced to the detention camp, which is kept separate and apart from the convict camp, in fact, in another part of the state; and take those men and teach them something. We have made stone masons and brick masons, and all kinds of mechanics, and at first they were entirely valueless—the first three months. At the end of that time we knew where they were.

Another thing: We always gave them hot meals. I gave them the right to have a cold meal, but if they wanted to march back on their own time, they would have a hot meal. They preferred the hot meal. They would march back on their own time rather than have a cold meal on the state's time.

I want to say this, and that is, I can't do anything until the 15th of January. Then the new administration comes back in—as this old administration was thrown out because

it killed the road question, the convict question—all over the state of Washington, without regard to politics.

Any time after the 15th of January, if you care to write me, I will be very glad to send you plans of our stockades, our bunk houses, all details of equipment and management and how we handle these men. Probably we are wrong. You may find some better way, but if you do I expect you to come back here a year from now and tell me.

H. C. PENFIELD (Bucyrus, O.): I want to ask, Mr. Hill, have you ever tried any convict labor in or near the large cities?

MR. HILL: Yes, sir. Well, I won't say large cities because there are no large cities out there; but we tried them near Bellingham, a city of perhaps, 30,000 or 35,000 people, and we had no trouble at all. The people out there at first were very much worried and alarmed about it. They thought convicts were bogey-men; didn't know they were just common ordinary men. Now the people say, "When are the convicts coming back? We want them back again. They build roads, they work." And the thing now is becoming the settled policy of the state. I have campaigned that state now for fifteen years. You can't go anywhere in Oregon or Washington today and find anybody that isn't entirely in favor of this convict work. By the referendum, people of Oregon voted to put the convicts of the counties at work, and before I came away they went out and established a convict camp in the county where Portland, Oregon, is situated. The state also passed a referendum putting the state convicts at work. So they have, by the vote of the common people, both the state and the county convicts at work.

P. W. SPAULDING (Evanston, Wyo.): Mr. Hill in his talk has omitted two or three other states in the West—they are the states of Utah, Colorado and Wyoming, which, to my own knowledge, use convict labor on the roads, and very successfully.

The state of Colorado has the honor system. They send their men out without guards, and the men themselves understand that if one leaves the camp, the balance will be brought in. They will send them into the mountains on rock work, in mountain passes and other places 15, 20 or 30 miles from the nearest town, and leave them

for days at a time, and then go around with the grub wagon with their supplies and check the men over and find them all there.

I believe in Utah where they have been doing it under the same system for two years they have had but one escape from their convict labor camp. The state of Wyoming, at our last Legislature, passed the same law, but we have guarded camps, guarded by the convicts themselves. That is, one or two of the convicts who are known to the authorities, who are not criminals at heart but yet are in the penitentiary, are given charge of the camp and provided with firearms, a rifle or a revolver, as a matter of awe, not to use. So far we have had no occasion to have them used, nor have we had a prisoner leave one of the camps. We find that it is going to be a help to us in building our roads. We believe it is a very good idea and one that should be adopted.

MR. HILL: I meant no discourtesy; I did not speak of those states because of lack of time.

MR. STILWELL: Weber County in which Ogden is located has for two years used its criminals in the same way. The convict labor plan has worked out very nicely. None of the convicts has escaped, and the work has been well done near the city of Ogden.

W. E. ATKINSON (State Highway Engineer of Louisiana): Mr. Chairman, we have been using convicts for about four years in Louisiana, and it has proved very satisfactory. In fact, they have become real road experts in their line and the cost of the road construction by convict labor runs about one-half of the cost by contract. Now, we usually have trusties, but occasionally they go off and don't come back. That may be due, possibly, to the different class of convicts that we have. The large majority of them are negroes, but nevertheless they are giving good service and proving very satisfactory.

We have a law in Louisiana providing for state aid to any parish that asks for it—either monetary aid or engineering aid. The state goes out and makes the preliminary surveys and estimates what the price would be to build a certain road. Over the state we are building mostly sand-clay roads, some gravel roads, petrolithic roads and shell roads. If the parish accepts the estimated price and desires to build by monetary aid, we give not over one-

half the cost, in money, to build that road, up to $50,000. We cannot exceed $50,000 a year for one parish. If they call for convict labor, then the state puts up the convicts against the money that the parish will put up. In that way we have encouraged good roads down there, and the convicts, as I said before, have been very satisfactory, and we have now several calls for convict aid.

PRESIDENT LEWIS: Mr. Chairman, I am very glad the gentleman from Louisiana has spoken, because I was going to ask if there was not someone here from the South, especially from the Gulf States, who would speak about the convict labor system as it is found there. I have seen something of it in Georgia and Alabama, where the system was formerly subject to grave abuse. I want to ask if some of these gentlemen will tell us whether the chain gang that was once seen in the town streets is still an institution in the South.

Mr. Marker, Commissioner of Highways, of Ohio, showed me yesterday a number of photographs of convicts employed on the state roads of Ohio; and I am sure there must be some gentleman in the audience from Ohio, who can enlighten us a bit about Ohio's experience. I can contribute nothing myself, but I think there is plenty of information here if it will only come out.

CHAIRMAN McLEAN: Is there anyone here from Ohio who can speak on this subject?

A. H. HINKLE (Deputy in Charge of Maintenance, Ohio State Highway Department, Columbus, O.): The Ohio Highway Department employed convicts during the summer of 1912 in the construction of an experimental road, south of the city of Columbus. The convicts were taken each day from the penitentiary to and from the work in a motor truck operated by a convict. The distance from the penitentiary to the work was about seven miles. After taking the convicts to the work in the morning the truck returned to the penitentiary for other duties during the day, returning again to the work to take the men home in the evening.

The convicts were all colored men, and the number working each day varied from 17 to 25. One guard, unarmed, accompanied the convicts. There was no effort on the part of the men to escape, even though they were sometimes scattered along the road for a distance of half a mile.

From the fact that the road that was constructed was an experimental road and the type of construction frequently changed, it was necessary to frequently change the occupation of the men. Some difficulty was experienced with the class of men that were being worked when these changes came too frequently, and where the occupation of the men was changed several times the same day their work was not always satisfactory. However, where we could keep the men employed at the same class of work for several days in succession, satisfactory results were secured.

For the services of the convicts $1.00 per day was paid to the Board of Administration, which board has charge of the various penal and correctional institutions of the state. No part of this pay went to the credit of the convicts. There is now a movement on foot which has for its object the enactment of a law providing for paying of the convicts, or applying to their credit, the sum of 50 cts. per day for their services.

Although the small amount of road work done by convicts in the state might be said to be experimental, yet enough has been done to prove that good results can be had in building a road where the type of construction does not frequently change, and it is believed that if even a small wage be paid the convict, or placed to his credit, still better results will be secured with a more humanizing effect upon the convict.

CHAIRMAN McLEAN: Is there any one who can speak on behalf of Georgia?

PRESIDENT LEWIS: How about the chain gangs of the southern states, Mr. Atkinson?

MR. ATKINSON: Yes, we have a few on the streets. Now, the chain gang is not the product of the penitentiary. The cities, you understand, use chain gangs. We don't put our convicts on the streets, with this exception however: Where we are building a road from one county seat to another county seat, and the road extends through a city or the town, we go on through the town or the city with our work so as to make the road continuous and join up. In a great many towns the streets are in pretty bad shape, and to set an example we give them a good road, or a good street through the town, so that it will encourage them and be an incentive for them to go ahead.

We do that, but we do not go into the cities and fill their streets with the chain gang at all—just merely where it connects up as a missing link.

PRESIDENT LEWIS: Are your convicts rented to the contractors still? In some of the southern states they used to rent the convicts to the contractors, and there were some pretty grave abuses developed.

MR. ATKINSON: We are using convicts on the levees down there; but I am quite sure that the contractors are not allowed to hire them any more. That is competing against outside labor. I don't think it is exactly right. We are using, though, the convicts on the levees. Of course, they are under the control of the State Board of Control, and under the engineers in charge of the levees; but we do not let the contractors have them any more.

JOHN M. GOODELL (Upper Montclair, New Jersey): The most interesting convict labor road work I ever saw personally was in the Canal Zone. In building the Panama Canal, the men have come in from all nations. I saw the police records of one month down there in which 41 different nations were represented in the list of men who had been arrested for minor and major offenses.

Down in the Canal Zone the men who were sentenced for long terms were housed for some time in a building which, although the authorities did their best to make it sanitary and healthful, nevertheless became so crowded that the problem of caring for these men was a serious tax, not only on the executive department, but also on the sanitary organization. The Isthmus is a narrow strip of land only about 40 miles wide. They had to have a road across it, so they have built one from Panama to Colon, mainly with these long-term convicts.

About two years ago, early one morning, Col. Goethals suggested that we should go out and see one of the best things he had to show on the Isthmus, a thing in which he took considerable interest personally. Walking out, we saw this crew of convicts starting out for their work, the riff-raff of every nation and of the whole seven seas. There were about 150 of them and they had suffered so much in confinement under the tropical living conditions that they were working on those roads gladly. A feature that those in charge of that work were particularly interested in, was the fact that those men had become a

good crew for that kind of labor. The plan was so successful that the Republic of Panama is using some of its convicts on road construction, and this spring I saw quite a large gang building a road to the old city of Panama, which has been in ruins since it was sacked by Sir Henry Morgan, but has lately been cleared out and will prove a place of pilgrimage when the canal is opened and many visitors stop on the Isthmus for sight-seeing.

CHAIRMAN McLEAN: I am sure we all appreciate the address of Mr. Hill. We, who know him, know that the subject on which he has spoken is very close to his heart—and it is a great big heart. Good roads and the restoration of men to their manhood are subjects which can always appeal to Mr. Hill. If there are no others to discuss the subject, we will pass to the next subject on the program. Mr. Roy Schenck, the State Commissioner of Immigration of Wyoming, will introduce the discussion on "The Division of Expense of Road Improvement over Town or Similar Local Unit, County, State and Nation."

DIVISION OF EXPENSE OF ROAD IMPROVEMENT OVER TOWN OR SIMILAR LOCAL UNIT, COUNTY, STATE AND NATION

ROY W. SCHENCK (State Commissioner of Immigration of Wyoming, and Secretary of the Laramie County Good Roads Association, Laramie, Wyo.): Mr. Chairman, I did not come prepared to discuss this topic, but it is something that we of the West, especially, are vitally interested in at the present time. The question of the division of the expense of road construction is something that eastern states probably have solved better than the western states.

At the present time there is considerable discussion as to how much the federal government will assist in the construction of certain highways. We have a problem, for instance, of public lands and great forests reserves. At the present time the federal government is giving 25 per cent. of its receipts from these forest reserves for the building and maintenance of roads in those states where these reserves are located. It leases the lands in the forest reserves to the stock men for grazing privileges, and has given this percentage of the receipts from the graz-

ing permits to the states for the building of roads. This amounts to quite a goodly sum in some of the public land states, but not as much as the federal government should give.

Now, as to the distribution of the expense among the smaller communities, a city, a town, or a county. That is something that we cannot solve unless we take into consideration the vital importance of all working in cooperation, and not any one specific locality being all content, thinking it is a little world in itself, and building up a little circle of roads within its borders, irrespective of which division is receiving the greatest benefit from the better roads. In our state, today, we are building a good system of state highways wherein the state contributes one dollar for every dollar spent by the county. Probably that system can be worked out for national highways, binding states together, where the federal government will contribute one dollar for the dollar spent by the county or by the state itself. We do not have in the West the township organizations that you have in the East, consequently I know nothing about how they might cooperate. Our smallest civil division is the county. The counties in the building of a state highway are contributing, as I say, an equal proportion with the state to a system of state highways, binding these various towns and counties together in a uniform system of good roads. If the federal government can be persuaded to assist in the formation of a national system of highways, binding the principal states of this country together, if the federal government will contribute dollar for dollar with the states and the counties through which it passes, the burden will not be heavy upon the nation's treasury, the burden will be greatly lightened for the smaller localities, and a great stimulus will be given to the great work of good roads.

CHAIRMAN McLEAN: The discussion is now open to the floor, gentlemen. I will be glad to hear from you.

MR. STILWELL: There may be a way in which some money can be procured for the building of one or more transcontinental highways which would aid the East as well as the West, without costing the federal government any great amount of money. It has been proposed that the federal government appropriate 1,000,000 acres of its comparatively worthless land to each of the western states.

Most of this land is not now valuable enough so that anyone will take it up under any of the governmental arrangements that have been made for homesteading, but it might bring 50 cts. to $1.25 per acre if it could be sold outright for grazing purposes. This land benefits no one now, since it cannot be obtained from the federal government under any of the existing laws. If this land were donated it would not be necessary to await its sale but each state might be required to issue bonds to the approximate value of its lands, and required to use the proceeds thereof for the immediate construction of links of the transcontinental highway under government supervision. When the lands were finally sold the proceeds would form a sinking fund to retire the bonds at maturity. Under this plan lands now lying idle would contribute to lower the high cost of living and the East, as well as the West, would be provided with roads for the use of transcontinental, as well as local, traffic.

This would be a scheme somewhat similar to the plan by which the federal government has aided irrigation. You will remember that the East has continually voted against any appropriation for irrigation in the West, and was perhaps justified in doing so. Finally a scheme was put through for using the funds from sales of public lands for irrigation purposes and a continuously rotating fund was formed. The plan has worked out admirably and nobody in the East who is posted in the matter would discontinue it. We in the West recognize that there would be no direct federal aid except as a part of a comprehensive system, perhaps such a system as proposed by Senator Cullum, which included the building of seven highways touching nearly every state, at an estimated cost of about $148,000,000. It is probable that such an expenditure will not be undertaken by the federal government, whereas the appropriation of a portion of the culled-over public domain would benefit everyone and harm no one. (Applause).

MR. ROGERS: I just wanted to call attention to a little notice that the government has sent out in regard to giving a few thousand dollars to each of the states. I know Michigan was allotted $10,000, on the condition that we find 50 continuous miles of highway that are traversed by mail routes, and on the further condition that the state contribute twice as much as the government. Now, that,

of course, amounts to $200 a mile on the part of the government and $400 a mile on the part of the state. We could easily comply with that condition if it were not for the fact of there having to be a continuous mail route. As far as we have gone into it—which is very casually—it did not seem possible to find 50 continuous miles of main highway traversed by mail routes.

MR. STILWELL: Did they ask for any particular character of improvements?

MR. ROGERS: No. sir.

J. J. HOPKINS (Rawlins, Wyo.): Mr. Chairman, I did not come here expecting to address this convention, but in the absence of those who were to speak I feel it my duty to bring the question of a national highway from ocean to ocean and across the state of Wyoming to the attention of this assembly. We wish to have a road built by which we can pass across the country from one end to the other.

This question is of vital importance to us. We are not provided with railroads by which we can go from one town or city to another, as in the older states; we have simply one great artery, the Union Pacific Railroad, going from east to west across the entire state of Wyoming. The counties through which this railroad passes are building a through road from east to west adjacent to the route of the railroad, as this route across the Rocky Mountains offers less resistance than any other that might be chosen.

The people of southern Wyoming understood that the question of a national highway was to be brought before this meeting, and that is why we are here, as we wish to know where that road is to be built so that the work we are doing in Wyoming on this "across the state" highway would conform with the road that the government might build.

Counties of southern Wyoming are expending more money in building good roads than for any other purpose. The county I am from, Carbon County, although sparsely populated, has expended in three years $123,000 on roads and bridges. The city of Rawlins, the county seat of Carbon County, has spent $3,000 each year for three years in putting shale on the streets of the city. This money was contributed by the citizens without regard to the money furnished by the city of Rawlins for that purpose, and I

think that Rawlins today has as good streets as any city, no matter what the material is they are built of.

It is a long distance from Wyoming here, and we feel as though we would like some expression from this gathering of men from all over the country in regard to this question of a national highway.

The year 1915 is close at hand, there will be many automobiles passing from the east to California to the exposition and, without doubt, nine-tenths of them will pass along this road through the state of Wyoming, and it seems to me, if there is anything going to be done, it should be done soon, so we may have some benefit of this road during our lifetime and not leave all the benefits to our children that are to come. I thank you, gentlemen. (Applause.)

MR. HILL: I am very glad to have heard what Mr. Hopkins said. First I call your attention for a moment to two things. First of all, article 8 of the constitution of the United States provides that the government shall establish post offices and post roads; second, to point out to you the fact that in the western states still remain these granted lands, to be disposed of by the national government. The country where we stand now was part of the land originally granted to the state of Connecticut. They sold this land here, as you know, and used the proceeds in the East. I am also aware of the fact that this is a deliberative and not a legislative assembly. I cannot speak for the East. I can say this, I try to keep in touch with the sentiment throughout the whole country. I think I may perhaps speak somewhat for different parts of the United States, born as I was in the South. Now, I can say this frankly, there has been appointed, as some of you perhaps know, a committee by the national government, consisting of six men, three from the Senate and three from the House. Jonathan Bourne, late senator from Oregon, is the chairman of that committee, and that committee is now investigating proposed routes across the United States with the intention of making recommendations to the national government as to where certain trunk lines of highway should be built.

I will say for the information of the gentleman from the state of Wyoming, who has just spoken, that in my opinion there are only two feasible routes that can be

utilized across the United States, independent of the route now being built across Canada. I belong to the Canadian Highway Association. They are now actually building a line of road from Vancouver, B. C., across, towards and on to Quebec, across the continent. I believe that road will be finished, unless we move rapidly, long before our own lines across the United States are finished. I am one of the active men, the vice president, of the Pacific Highway Commission. We are now engaged in locating and partially in constructing a line of highway to run from Vancouver, B. C., through to Tia Juana, Mexico, and that road will be finished by 1915. I shall be very much disappointed if it isn't finished down there. To go back to Wyoming, I know of only two routes that are available to cross the continent in the United States. One is the territory wherein the gentleman lives—crossing the state there and going down the Columbia River following the water grade. The other line is further south, not far from the line of the Atchison, Topeka & Santa Fe Railroad, known as the Old Santa Fe Trail. So I think the gentleman will feel very much encouraged because that is where the line will have to go. Nature fixed these things, and not the engineers. (Applause.)

A. R. HIRST (State Highway Engineer of Wisconsin): Mr. Chairman, we have found in the development of work in our own state that the theory that each community benefited should pay a part of the cost of the highways is a rather good theory to proceed on, hence we are utilizing the town and the county and the state. I believe that if we go a step further and adopt a fourth community, the United States, that it ought to be something along the lines of having the United States government lay out through routes through the United States and having the government pay a certain part of the cost when any of these communities improves a certain section of this highway in conformity with plans approved by the national department.

It seems unfair to me to lay out certain transcontinental routes benefiting some certain counties, in a few states, possibly not touching over one-third of the states, and to charge the whole cost to the whole United States. I believe that the ideal national highway system would be one that assessed, first, a certain percentage of the cost to the

smallest community passed through, the county; second, the state, and third, the United States, and, of course, all of these units have an interest in varying proportions. The idea of adopting a national highway system simply because it does not seem to cost anybody anything, or because the cost is paid from a distant source, I think is a poor theory. But the theory of developing these great trunk highways so that Wisconsin will not build a road that does not connect with Minnesota, or Illinois or Michigan, and of working out a system so that we must build along certain lines to get national aid, just as our counties must build along certain lines to get state aid, I believe is essentially the right principle. And I believe that this principle will have to be adopted if dissatisfaction with the general scheme is not going to be evidenced in all the states which help to pay but get little if any direct benefit.

R. A. MEEKER (State Highway Engineer of New Jersey): Mr. Chairman, coming as I do from the first state aid state in the Union, I think it would be well to give the members present a little leaf from our experience.

Why did New Jersey adopt state aid? Because a few wide-awake people in certain localities, realizing the benefits to be derived from better means of communication, began to improve their roads. They extended these improvements to the boundaries of adjoining localities. Then, the residents in the first section said, "Why is it that we, who begin our journey over a good road, must, for the remainder of the distance, use a bad road? And the people in the adjoining community enjoy what we have paid for. We don't think it is fair." This sentiment spread from the townships to the counties and was voiced in the phrase: "We think that we, in this township, have improved our roads and the other townships ought to do something." Some of the townships were not as wealthy as the others, and they said they couldn't afford it. The sentiment grew until the counties were induced to make appropriations and we had a law passed known as "A County Bonding Act," whereby the question was submitted to the voters of the county. Then, certain counties, more progressive than the others, availed themselves of the benefits and privileges of this law and improved their county roads. Against this practice the same objection arose. "Here in this county we have good roads but we

have to travel over bad roads to reach the borders of our state. We think that it is time that the state should assist the towns and the county in building roads across the entire state."

That has been the method of the growth, that was the origin of state aid, and now as many of the states of the union have improved their roads to their very borders, the time has come when these separate communities should be united in one. The towns have helped themselves, the counties have helped themselves, the states have helped themselves, and each has gone almost to its limit. In the old days of the stagecoach, before the railroads, we had turnpikes that were maintained by private corporations.

After the advent of the railroad, a great many of these turnpikes fell into disuse and many of the old taverns along these turnpikes and a great many of the smaller towns that did not happen to be along the line of the railroads, instead of increasing in wealth and population, decreased. Now that we have improved the roads along the lines of these old turnpikes, as a result many of these old places have taken on new life and have developed a degree of prosperity that they never knew even in their best days. Now, it isn't right for New Jersey which has 31 per cent. of its highways improved, to sit down and say to Wyoming, for instance, that we know has a very little improved mileage, "Well, we have got all that we want and you fellows go and get it as we did." Now, when the people in Wyoming or in Utah or in Washington show that they appreciate the value of good roads and do all they can, then, isn't it time for all of us to get together and petition the national government to assist us? We don't go to it as paupers, we don't want it to give us the roads. We will do our share; we will give a certain proportion of the cost, and let the government pay a proportion which may be determined upon later for the through travel.

There was a time when a man thought if he traveled over 30 miles a day with a load he was doing a wonderful thing, and it was talked about around the fireside and at the corner store. In our state many men now load vans and drive them 200 miles. They go out of the state because it is only 90 miles across our little state and if a man in New Jersey started to go 200 miles he would probably traverse three states. In fact, I have known a

man to go across the state of New Jersey, across the lower part of New York, and through Connecticut into Rhode Island with a loaded van. Why? Because he had good roads. Now, while he pays taxes in New Jersey, he derives benefit from the money which has been spent in New York and Connecticut and Rhode Island. Carrying out this thought, why should not the government of the United States help the states who have helped themselves to help one another? (Applause.)

MR. SPAULDING: Mr. Chairman, I have just a word to show you we are helping ourselves. Since I spoke in the meeting Tuesday, I have received figures from our several counties which are our road communities, and during this year and during the year 1911, we have averaged yearly $4 per capita of our population expended upon our roads. Now, I believe when you figure the per capita and your state valuations, we are spending as much as you eastern people do. One gentlemen spoke here about 50 miles of post roads not being found in any district of the country. There is the whole question of this road business—it is a continuous highway so that you can go from one place to the other by following one general road, regardless of county lines, regardless of your state lines, a thoroughfare that will take you from one coast to the other, or from the Missouri River to the Pacific Ocean, or from the north to the south, regardless of the territorial divisions through which you pass. That is what we are advocating and working for, and willing and able to do our share.

MR. ROGERS: Mr. Chairman, I do not think I made myself clearly understood. It is not that we haven't many places where there are 50 miles of continuous road in our state, but the trouble is to get 50 miles of continuous road which is now traversed by mail routes—other than railroads, a public highway.

MR. PENFIELD: I would like to ask why that provision was put in there?

MR. ROGERS: I don't know. That is the handicap; we would like to get that $10,000, and that is the only condition that we can not readily comply with.

MR. STILWELL: Mr. Chairman, in 1911, the state of Utah and many of the counties of the state made their appropriations for good roads work for a period of two years. In all, more than $2,000,000 for less than 400,000

people were appropriated, or more than $5 per capita. At the present time what is admitted to be the best transcontinental automobile route crosses Weber County, in which Ogden is situated, over a road nearly all of which is macadamized and which the county agrees to complete at its own expense. Weber County is doing its share and asks no aid. However, in the state of Utah there are about 40 miles near the eastern boundary and about 60 miles near the western boundary that nobody in Utah ever traverses except by automobile. At best, not 100 horse-drawn vehicles will go over that 100 miles in a year, and naturally the taxpayer is not interested in the improvement of these roads. Our improved roads extend from north to south, and the bulk of the population of the state occupies a narrow strip west of the Wasatch Mountains, not over 10 per cent. of the state being under cultivation. Thus the bulk of the highway traffic is from north to south, whereas the transcontinental automobile route crosses Utah from east to west. There are no large cities east or west of Utah to which the farmer can haul his products, thus no one travels out of Utah either to the east or to the west except by rail or automobile. But since this 100 miles of road must be used by the trancontinental tourist it is obvious that the state of Utah is deserving of government aid for the improvement of these sections for which its own inhabitants have no direct use. More than a thousand automobiles went through Ogden or Salt Lake City last year. They came from outside the state. Next year this traffic will be doubled, and motor magazines estimate that 40,000 people will visit California by automobile in 1915, most of whom will cross Utah over 100 miles of road which must be built expressly for their use.

PRESIDENT LEWIS: Mr. Chairman, I don't know that I can contribute anything of value to this particular question, but I want to emphasize what, in my judgment, is the fundamental consideration underlying the whole problem, and that is the distribution of the cost in accordance with the benefit—always taking into account ability to pay. In my judgment we can start off with the general proposition that where there is benefit there should be some charge, some payment, some contribution toward the cost, and that contribution may be five per cent., it may be ten per cent., it may be twenty-five, or it may be

fifty per cent. If the improvement to be made is of purely local benefit, the entire cost might properly be placed upon the property or the locality so benefited. It seems to me unfair, yes, unrighteous, that the owner of the property or the community that receives a special benefit, should escape a special contribution. Of course, the relative benefit is a very difficult thing to determine, and one would naturally be reluctant to assume the responsibility of such determination. Somebody has got to do some guessing. We may make the best guess we can, but will often go wrong, but we should try to guess as nearly right as possible as to what is that equitable distribution of cost, taking into account, as I said before, ability to pay. I think that in this connection the remarks of the gentleman from Wyoming should be given great weight. The value of a highway, as of any other improvement, is dependent largely upon the extent to which it can be used by others than those living upon it.

I think that our cities have been too much disposed to consider themselves independent of the country about them, and their highways have not been properly articulated with those of the country about and behind them,—with those of the county and of the state. Why is not the highway system of a city like this in which we meet, or even of a larger city, a part of the county system? Why is not every county system a part of the state system? Why is not every state system a part of an interstate or a great national system? In Great Britain they have recently enacted a law known as the English Town Plans Act; and the underlying principal of the act is this, that every city and every town, is intimately related not only to the country around it, and behind it, but to the neighboring cities and towns. In a thickly-settled country like Great Britain, comprehensive town planning, and that means street and road planning, will cover the entire country. Similar conditions exist in some of our densely populated states, and they will exist in our states now sparsely settled but blessed with an active and energetic population, before many generations or many decades have passed. The problem, therefore, that confronts us is to treat each highway in its relation not alone to the abutting owner, not alone to the nearest village or even the county, but in its relation to the great state system and the inter-

state system. While I cannot even suggest any rule for division of expense, that expense should be apportioned as nearly as possible in accordance with the benefit to the abutting owner, the town, the county, the state, the nation. That is no reason why we should expect the federal government or the state to assume in every case a large proportion of the cost. Such aid is frequently unnecessary; but in some cases without that distribution of expense on pretty liberal lines, the improvement would be impossible. The Superintendent of Highways of New York in the discussion yesterday said that a bond issue for a long term of years was frequently justified because farm lands along what is now a wretched highway would double or treble or quadruple in value if that highway were improved. That is a two-edged argument. If its value is doubled or trebled, why cannot that farm which is so enhanced in value make a very substantial contribution toward the cost of the improvement? Why unload it upon the state and impair its borrowing capacity for other purposes when there is going to be a direct enhancement of value? And if I am right in saying that in all fairness and righteousness the burden should be placed, as nearly as we can do so, in accordance with the benefit, I cannot see why those lands which are certainly going to be increased in value, should not bear their fair part of the burden. (Applause.)

J. CHARLES DAYTON (Superintendent of Highways of Cayuga County, New York, Auburn, N. Y.): Mr. Chairman, there is just one answer to that: Five years ago in New York when we built our highways under the plan of 50 per cent. contributed by the state, 35 per cent. by the county, and 15 per cent. by the township through which the roads were to be built, it was almost impossible to get the people, the voters, to want roads. They would not pay their 15 per cent. They did not appreciate the value of good roads. There is no use of my arguing to this audience here as to the value of good roads for you are all committed in their favor, as I am; but to induce the people to favor good roads, to make the roads a practical thing—something that should be done—seemed impossible under that plan. But now since they have had a chance to see the roads, there is a change in the sentiment. Our Legislature at the last session changed the law in regard to these county highways, so that 65 per cent. is paid for

by the state and 35 per cent. by the county, which I think has been a mistake. At a meeting of our County Board of Supervisors our applications are for four times as many county roads as have been built in the last five years, simply because they think they can get something for nothing; and the taxes will not stand for it. It was necessary first to get help from the state and from the county in order to get the thing started. That is true in New York, and I have no doubt it is true in other states which possibly have not advanced as far in road work as New York has.

MR. MEEKER: Mr. Chairman, it would seem that while the property along the improved highway is enhanced in value by reason of the improved road that you build there, really it is unfair that the abutting property should practically pay the entire cost of the improvement because our years of experience have taught us that we must spend more for maintenance than we do for construction. Admitting the gentlemen's argument that the property is enhanced in value by good roads, it does not follow that it should pay the entire cost. If property is properly assessed it will pay in taxes much more than it ever paid before the road was improved, and the money that is paid, in the way of taxes on the increased valuation, will go far toward the maintenance of these improved roads.

Now, maintenance is a question that in the older states is a very serious and a very expensive one. Sometimes in speaking of good roads and the improvement of roads, we lose sight of the fact that the first cost is not all the cost. Though property may be greatly enhanced in value, sometimes four and five hundred per cent., yet by calling our assessors' attention to the fact of the increased value of the property and therefore that he must assess in accordance with the value of the property along those improved roads the result is that property along improved roads is assessed with us at a much higher value than property on unimproved roads. This money goes toward the maintenance of roads, and this annual charge is in many cases from five to ten per cent. of the original cost of the roads.

PRESIDENT LEWIS: Mr. Chairman, I believe that there is a fallacy in the argument so frequently advanced that if property is increased in value by any act or improvement carried out by the public it will be assessed

higher and it will pay increased taxes, and that is tantamount to its paying part of the cost of the improvement. I do not think this argument will bear analysis. If I inherit or if somebody presents me with a house, I expect to pay taxes on that house, but that does not mean I have paid for it. That is a present to me. Of course I expect to pay taxes on it. If the state does something that enhances the value of my property—doubles it, of course I pay more taxes on it because I have more property. I do not pay for the property that was given to me by a friend, or by will, or given to me by the state, simply because I pay more in taxes. Because I am paying the taxes on what I have, that does not mean that I am paying for what was presented to me. I did not buy it. It was a gift. That gift is not fair to my neighbor. (Applause.)

CHAIRMAN McLEAN: I would like to ask if you are taxed an acreage or a frontage tax, and also taxed on increased assessment, are you taxed twice for the improvement?

PRESIDENT LEWIS: I don't think so, Mr. Chairman. I think that your increased assessment is simply for increased value. You have more money or you can borrow more money on your property; you have more property, and a man has to pay taxes on the property he owns. I don't think he is paying for that property when he pays on additional assessed value. I don't think it is double taxation.

J. M. GOODELL (Upper Montclair, N. J.): I am delighted with what Mr. Lewis has just said, because he has brought up a thing that I consider a most important matter. In the parts of Massachusetts where the State Highway Commission has built most of its beautiful roads, their effect in increasing the value of farms is well recognized. The farmer can go to a local bank and raise more money on his property than before, because the local banks have learned the effect of good roads on farm values. I am interested in a demonstration farm down on Cape Cod, where there is nothing but sand and farming is laughed at now. Any man who tries to go off on one of the few good roads there, might just as well make up his mind that it is a day's journey to go a dozen miles. He it stuck in loose sand. When this demonstration farm is completed there isn't a bank anywhere around there that will advance us more than a penny. We have got to go

into a different part of the state, or perhaps into New York, to get the money for operating charges. It will be some years before the local banks wake up to the increased value of our property. Now, I think it falls very hard on the farmer, Mr. Chairman, in some sections of the country to meet the expense of the first good roads, although he gets the present that Mr. Lewis speaks of; and I think that a very important feature of this whole highway problem in the country districts is to educate the local banks as quickly as possible to appreciate the value of good roads. It is true that such roads increase the value of farms, but what help is that to the farmer who finds his local banks do not believe it, and do not lend money more easily to him? A ray of light is thrown on the subject by what the bankers of Illinois are doing. The Bankers' Association of Illinois is helping the farmers tremendously toward road improvements, and I regard that really as one of the best things that have recently taken place to advance the cause of good roads. The Illinois bankers are standing behind the farmers when they stand behind the good roads movement.

M. W. TORKELSON (Bridge Engineer, Wisconsin Highway Commission): It is and has been the policy of this government to improve certain waterways and certain harbors, and the greatest beneficiaries of this system have been the large seaports of the east. The improvements have always been paid for out of the revenues of the national government. It has never been advanced as an argument that the particular cities deriving the greatest benefit from these improvements should pay the largest cost. It has all been paid by the general government. I do not see why that question should be raised against roads. If the people who derive the greatest benefit from the roads should bear a greater percentage of the cost, then these people who derive the greatest benefit from these great harbor improvements, should also pay the greatest share of the cost; and I feel that we people who live in the interior who do not derive any direct benefit from these harbor improvements have only one chance to get any benefit from the government and that is through government aid to roads.

MR. ROGERS: I think there is also a "comeback" to this argument. If it were not for the improvement of the

great waterway from Chicago to Buffalo, what would you be paying today for an all-rail freight from Chicago to Buffalo? There is something there that we must consider. and that should interest every shipper, viz., the freight rate from Chicago to Buffalo and on to the East. For the same reason the Erie Canal was built across the state of New York. That is the only argument I can see for it.

But there is still a little more to this. I think perhaps my friend from New Jersey is not entirely in error. From the fact that you have increased the selling price of a poor farm in New Jersey, you have not increased the earning capacity of that farm, particularly to the farmer who is still trying to earn his living off the soil. In other words, you have not improved the soil. You have not made it possible for him to raise another dollar per acre off that soil more than what he did before. You may have made it a little easier for him to market his product, but you have not increased his earning capacity.

MR. MEEKER: I do not want to take up too much time, but the good road does increase the value of the farm. Why? I will give you a little story to illustrate the reason.

Into our office one day came a farmer, and he was a pretty rough looking customer, what you would sometimes call a "hayseed." He said, "Where is the Commissioner?" Well, I thought he was coming in—it was in the earlier days—to give the commissioner a call down for spending so much money for improving roads. I said, "He isn't here, he will probably be in in about an hour." "Well," he said, "I will tell you what I want. We want a stone road in front of our farm." He said, "Three miles over from us the fellows are hauling their stuff to market and we have got to sit still and let the rats eat the grain up because we can't get our stuff to market, and the prices are way up now and grain is bringing 20 per cent. more than it did just after threshing time, and we want to get some of that benefit; and we can't because we can't get our stuff to market and it is just rotting."

He knew that a good road enhanced the value of his farm. And another value we have, an immediate and direct value, is this: a great deal of our soil is light soil. It was formerly called poor ground, and even in New Jersey it was pretty cheap land. It sold for $5 an acre. Now you can't buy it for $150. Why? Because they are raising

truck on it, and they are hauling that truck to Philadelphia and other places. They haul into Philadelphia from 30 and 40 miles out. In the old days they hauled 60 half-bushel baskets. Now they haul 240; and they haul two loads a day each way. It took a man with two horses and sometimes three to get 60 baskets of produce to market; and the horses were generally pretty poor. They fed them well, but they looked bad; they were just about pulled to death. Now, the horses are in good condition, they haul those 240 baskets to market, they market the stuff, and they get a good price for it. It is true the land is the same as it was before, but over the good roads they are enabled to haul manure back from the cities and to put that on the farm. If the good road enables the farmer and the truck raiser to produce from four to eight times as much stuff as they did before and enables him to get that stuff to market with one-quarter the effort and one-quarter the wear and tear on his horses and his teams, isn't that farm worth more money?

CHAIRMAN McLEAN: The next subject for consideration is "Correction of Alignment and Grade in Existing Highways," an engineering subject which will be introduced by Mr. J. Y. McClintock, of Rochester, N. Y.

CORRECTION OF ALIGNMENT AND GRADE IN EXISTING HIGHWAYS

J. Y. McCLINTOCK (County Superintendent of Highways of Monroe County, New York): Mr. President and Gentlemen:—It is a subject altogether too large to do justice to in ten minutes, and all I will try to do is to suggest some little points of my own experience.

In the older days, in designing grades for highways 4 per cent. was considered a reasonable grade, so that horses could trot down it without appreciable injury. Today the controlling thing is the amount of load you can haul and the automobiles. I was brought up on an old, conservative railroad, one of the few perhaps in this country that has the record of paying dividends since 1836, the old Boston & Maine, which was built as cheaply as a railroad could be built and still get passengers over it. My observation of the building of railroads all over this country is that they were built just as cheaply as they could be built, and the

work of the later years has been to rebuild them after they had got some courage, after they had built up the business, and after the necessity of reducing grades had come. Of late years that has been a great deal of the work of the Pennsylvania, the Lackawanna, the New York Central and the Pacific roads.

Now, to my mind, it is similar with this system of highways. It is not simply a piece of road here, and a piece of road there, but it has to be looked at as a whole. It is evident to me that there is going to be transportation on it far longer and many more miles than they ever dreamed of. I remember the first good road I ever went to look at was with Mr. Meeker down at Camden, and it was perfectly wonderful to us out there 30 miles on an old stone road to see the people who were actually hauling in by horses to the market great big loads that we never would think of doing in our country. Now, I am living in a county, in a large one, of which it is said that the value of its farm products is greater than those of any other county in the United States with only one exception, and that is the great big county of Lancaster down near the Philadelphia market; and every bit of our land is productive. The loads hauled, the produce of the farm, are the heaviest kind of such things. We want the grades cut down there. When a grade is left as much as 4 per cent., it is a big detriment. You cannot do that in other districts. I have a notion that the proper way to look at it is to divide the system up into sections the same as is done on the railroad system. You may call it a mountain section or a flat section; and in a mountain section if it is possible to get the low grades without too much cost it ought to be done.

But there is another thing that comes in, that I have run up against lately in our city. We have organized automobilists and they are a great force, nearly 2,000, and they are active people of the community, and we have the problem, for instance, of cutting down—we have only got a few hills in our particular county—of cutting down to a 7 per cent. grade over a hill, or going around it. The sentiment of the people for the moment is to go over the hill in preference to going around because most of them are driving for pleasure or they are driving light cars and think they know it is an element of danger to have a curve put into a road. Yet the increase of motor trucks

there is possibly as great as in most of the other large cities. Everybody is buying motor trucks and they are carrying great loads. They are going for the 5-ton trucks regularly, and when it comes to going over that 7 per cent. grade, then it cuts off the earning capacity of trucks in carrying loads.

Two things have got to be considered carefully to do justice to the subject. Lately our postmaster—I presume like those of other parcel and big distributing offices—has been having great trouble not knowing what is going to happen after the going into effect of the parcel post law. A good many of us believe that the eleven pound limit is not going to be the future limit, that they are going further. But even with the eleven pound limit it means that in the thickly settled portions of the country, instead of the rural man going out with a bundle of letters and spending his time and getting around over the roads, somebody has got to go out with teams. They have got to go around over these roads, and it means the evident use of power wagons, and in our section where we can afford to, we cut around the curves. A right-angled turn with a 300-ft. radius is considered in New York state good practice. But still, we do not believe in going too far in the original construction and cut down grades in our section less than 9 per cent. That is with the idea that in the future, when the business requires it, changes can be made in the grades exactly as has been done with the railroads. I think that is all I have to say. (Applause.)

CHAIRMAN McLEAN: Gentlemen, the question is open to the floor of the house. We might hear from Mr. Durham, Chief Engineer of the Borough of Manhattan. I believe that he has had some experience in that class of work, and can possibly tell us what New York has suffered by failure to correct the grades before the city and its suburbs had increased so largely in population.

H. W. DURHAM (Chief Engineer of Highways, Borough of Manhattan, New York City): Gentlemen, all I can say on this subject is in the line of a warning and not as an example. My experience in road construction has been devoted almost entirely to two of the oldest cities in America, both of which are built up on predetermined lines, but in each of which we had a different method in which we could handle it. In the city of Panama, where I

had the honor of having charge of the municipal improvement by the United States government for two or three years in connection with the Panama Canal work, we had an old city laid out on lines that were adequate at the time it was originally constructed and for many years thereafter, and we have very much the same problem in New York, with the difference that in Panama the United States Government, through the Isthmian Canal Commission, under which I was working, had almost absolute power to do what it saw fit to improve municipal sanitary conditions. That could be construed broadly, in fact, to include water works, sewers, and even incidentally to the alignment of the streets with proper grades to meet the traffic which was thrown upon them, with the large amount of business coming through the canal work. If the people in a certain street did not like the way we did the paving there, why, that was about what they could do about it. I do not mean that we followed an arbitrary plan of persecution, but it was a broad scheme of putting in improvements for the general good, irrespective of local conditions.

On Manhattan Island, we have a city laid out over one hundred years ago on lines supposed to be broadly adequate for all time, but years ago outgrown. But that city has been built so solidly that it is almost impossible to correct any errors in lines or grades except at prohibitive expense. Certain streets, such as the street through which the New York subway was built a dozen years ago and the proposed extension of Seventh Ave. on the west side where there is to be another subway, have been widened and straightened at an expense of millions of dollars. Those were isolated cases where absolute necessity demanded it. Ordinarily we have to take the streets the way we find them, and all we can do is to correct the minor errors in grade—even at a hardship, sometimes, to the adjacent owners in requiring them to lower or raise their sidewalks—and to require the removal of all illegal encroachments upon the street.

During the term of the present Borough President of Manhattan several million dollars have been spent by property owners in moving encroachments—stoops, colonnades, show window cases and other obstructions—back to the building line to provide sidewalks of adequate

width for the travel and to permit of the city changing the curbs to accommodate the traffic on the streets. We are repaving this year—or we will have repaved at the end of this year—some 56 miles of street, and in many of those streets we are providing for the traffic by widening the space between the curbs, getting additional sidewalk space, by the removal of street obstructions. That is a final resort, and there is no going back of that, except in certain streets like Nassau, where it will be possible to build arcades, already begun at somewhat excessive expense, on the lower floor of the buildings so as to take the entire width of the street between building lines for team travel, or in the case of such a street throwing it entirely open to foot traffic and putting the teams on some adjacent street. The history of Manhattan gives a warning, not a lesson, for others who have been planning cities. What we have had to do so as to give in a minor degree such adequate convenience for travel, is the same as Washington has had to do in its plan laid out 100 years ago at the same time as the plan of New York. The Washington plan was adopted with the idea of future growth, whereas in Manhattan, while there was some plan for the future, the possibilities of the way in which travel would grow were not sufficiently considered.

Only one other point occurs to me that may be of slight interest to you in the matter of alignment. It is not so much the alignment, however, of the actual street and grade, in a practical sense, as the question of alignment of men. We have had a good deal of discussion in the past two or three days on different points of view of engineer and contractor and public, and yet we sometimes forget that we are all allied together, not for an ultimate end, but for a means to the end. The highways are means for the service of the public and merely one of the methods by which we employ—in the old egineering definition—the great sources of power in nature harnessed for the use and convenience of mankind. I don't think there is such a difference of standpoint between the men who are studying out in Massachusetts in the most scientific manner the development of highways for intense travel and the men who in some of the other less densely settled states with a limited appropriation and a great amount of work to do, are having to get what they can for their money.

When I was down in Nicaragua on permanent surveys for the Canal a dozen years ago we were cutting a pathway through the jungle, and when we came to ford a stream we did not stop to calculate the strength of the bridge across it. We found a big tree and we cut it down and went over it, or we would get a line across it which those men who couldn't swim could hang on to going across. But in constructing the locks for tho Panama Canal, they are putting steel work down there where the error of an eighth of an inch makes a difference; where the nice construction requires the strength of materials to be calculated. So it is a question of doing what we can to get what, after all is the basis of good engineering in any case, something that will serve its purpose well at the least cost; and I think we can be satisfied if we produce work that returns value for the money invested, and feel when it wears out, that that which was worn out has produced its cost in results to the people, and if we leave to the next generation no errors either in alignment or grade, or cost of things that we have used for them to pay for. (Applause.)

L. R. GRABILL (Superintendent of County Roads of the District of Columbia): Mr. Chairman, the discussion of this question seems to have departed somewhat from the subject as outlined, and still I do not know that the departure is at all not to be expected. The question is the correction of alignment and grade in existing roads. That is something that is oftentimes quite difficult. We have to stick to the alignment of the roads as we find them, as a rule, or else resort to expensive condemnation proceedings; and the only thing we can correct, very often, is the grade. In a thickly populated section, as the gentleman who has just spoken has called to your attention, the correction of the grade becomes very difficult, on account of the water mains and gas mains and other substructures. The correction of alignment and grade after a city becomes built up and extends out into the suburbs, where improvements of all kinds are carried out, is a very difficult thing; and for that reason I think it may be of interest to this association to know just what we are doing in one little section of the country to prevent the necessity of correction after a time.

As you all know, the city of Washington was built on a

design which was laid out, so far as alignment was concerned, before there was ever a building on the ground, and that part of the plan of the city was carried out precisely with respect to the alignment. The grades were not originally established by that same plan. They were developed later, and a great deal of trouble resulted at about the time a gentleman, who was at that time called by some "Boss Shepherd," who was the Governor of the District, reduced some of the original grades to proper grades, and that very subject caused almost the execration at that time, of Governor Shepherd, although what he did was afterwards proved to be the thing that should have been done. He established the grades of some of the principal streets without respect to the buildings and the improvements that already existed, and he at that time apparently destroyed property values in a great many cases. People denounced him for his arbitrary action, and he left the city; but it was not many years, gentlemen, before he came back to Washington, and the greatest ovation was given him because people by that time had realized the benefit of what he had done.

The entire area of the District of Columbia was not included in the original plan of Washington City. Washington City, i. e., the city proper, is a limited part of the District of Columbia, although the District itself has an area of only 70 square miles.

To avoid what happened in the case of Governor Shepherd, the District Commissioners sent to Congress and asked for a law establishing a street extension plan for the whole of the District extending to the very boundaries. They did not do that until after various subdivisions had grown up in a haphazard way without respect to any lines except property lines and without respect to any grades except those which were practicable within those property lines. The man who was subdividing a piece of property did not care for the future as long as he got a grade that did not cost him too much to work out. We had this situation on the outside of the original city. From about 1870 to 1890, we had a period of twenty years during which subdivisions were made almost regardless of any connection and almost without regard to alignment or to grade. That got us into

the greatest mess or hodgepodge of streets that did not connect, and grades that did not connect, that you can conceive of, in certain sections. Then Congress which is the ruling body or Town Council, as you might say, of the District of Columbia (and sometimes the people think it is very unfortunate that they haven't got any voice in those matters), passed a law at the recommendation of the Commissioners of the District to extend the street extension plan to the boundaries of the District, and then was prepared a plan, which outlined every street to the District line, carrying out, as far as possible, a similar plan to that prepared by Major L'Enfant, which has proved so valuable. And now we are working on that plan. A great deal of this land is not yet subdivided, but when it does come into a subdivision, it must conform to this plan, with respect to the width of the streets and of the alleys, and other dimensions. They can make only certain minor changes.

We find it very difficult as I said to change a grade after a section has been built up. If, in order to get a good grade you have to cut or fill, say 20 ft., that makes considerable of a howl. So we are working out the grades now on the unsubdivided land which perhaps will not be built up for 50 years to come, but we are establishing correct grades which will give those streets good grades by the time they are built up. While that involves in some cases a great deal of cutting and filling we are relying on the good sense of the property owners to make those cuts and fills when they come to subdivide their land. I thank you gentlemen. (Applause.)

R. A. MEEKER (State Highway Engineer of New Jersey): Mr. Chairman, in speaking of the correction of alignment on country roads as distinguished from city streets and also the correction of grades, we find that in the last 20 years we have had to change our ideas considerably. We now insist upon a maximum grade of 5 per cent. unless some very unusual conditions arise. The only variation in the last two years from that plan was a grade of 17 per cent. which we cut down to 6.

In the early days little was thought of the alignment of country roads. The grade, of course, was a matter of necessity, and the improvement of the surface of the

road was all that was regarded, but the advent of the motor has changed all of that, and now we are compelled to have a standard, a maximum curvature on all new roads. We will not allow any curvature of over 6 degrees, or a radius of 955 ft., on any of our improved state roads. We do not try to get what you would call railroad work, but do strive to get from a 4-degree curve to a 6-degree curve on our main roads. Officials said at first that this was a very arbitrary ruling. Under the provisons of our motor vehicle act, the maximum speed in the open country is 25 miles an hour. The line of sight of unobstructed vision on a 30-ft. road on a 6-degree curve is 350 ft. Two motor vehicles aproaching each other at the legal rate of speed, 25 miles an hour, would occupy 4¼ seconds in covering that distance. Is that too much time to give a man to miss another one? That is the reason for our rule.

MR. HILL: I want to say that the state of Washington has surveyed 1,500 miles of trunk line roads. It has no grade in the state over 5 per cent., although we have some mountains 15,000 ft. high. We adopted exactly the rules of New Jersey.

DELEGATE: Have you any right-angled turns in New Jersey?

MR. MEEKER: We have no right-angled turns unless it is a crossroad, or approximately right-angled. In a village, I had one of those cases up before me Monday before I came here. I simply told them that we would not improve that road through that little place unless they gave us a curve of a maximum of 6 degrees; and after very much protest on the part of some of the parties, one man agreed to move one building and tear down another one. This may seem a litle bit harsh, but we have to consider not only the convenience of the traveling public, but the value of human life. We do not want to build roads that are so good that people will travel so fast they will get killed, and we do not want to have collisions on our roads. We do not want to build death traps, and we are not going to if we can help it.

CHAIRMAN McLEAN: There does not appear to be anything further from the floor of the house on the subject before us and I will therefore declare discussion closed.

A fourth subject was so popular with those attending

the convention that it was decided to include it in our program of this forenoon. There was someone present who had a paper on this subject, but the president has been unable to say who it is. The subject is an extremely important one, and of intense interest to the public—not only those who use the roads, but those whose property adjoins the roads. As the paper is not forthcoming, I will ask Mr. J. H. MacDonald, of Connecticut, to give us something from his experience in that state.

DUST PREVENTION

JAMES H. MacDONALD (State Highway Commissioner of Connecticut): I don't know, Mr. President, just what I can say in regard to this matter. I just came through the exhibition, and I saw quite a number of gentlemen who have these dust preventives and they perhaps could discuss it a good deal better than any commissioner. I felt, in taking up a question of this kind that it was a good deal like the man who had grates to sell. He said, "If you buy one of my grates, you can save half the price of your coal a year; if you buy two of my grates you will save all the price of your coal, and if you buy three of my grates you will have coal to sell." (Laughter.)

It is astonishing the number of palliatives that we have, and the fact that this subject, Mr. Chairman, is a part of this matter we are here to discuss and take part in shows what progress this movement has made. Only a few years ago it was a question of getting out of the mud; and it is really one of the elementary branches, in my judgment, and belongs more to the chemist and the doctor than it does to the road builder. There are a whole lot of people in this great and glorious country of ours who believe they have hardly got the elementary branches of road building sufficiently to give even a serious thought to the dust. They are thinking more about getting out of the mud, and I think myself that the best way to get rid of the dust is to build a good substantial road, and when you have built that road then build the other roads that are auxiliaries to that road, because I find that many times the hoof and the wheel carry dirt on the very best built roads in the world and use them as door mats. And when you expend, five, ten, fifteen or twenty thousand dollars

for a door mat to wipe off the hoof and the wheel of the vehicle, you are going into an expensive proposition. And so the argument of dust laying would be this: Take all of your main arteries—do not leave any intervals because every one will tell you that the weakest point in a road is that which controls, whether it is ten or one hundred miles—and build all of them as good substantial roads. I confess that, having a great many friends amongst the gentlemen who are selling these dust preventives, and desiring to live at least long enough to get back to the bosom of my family and the dear ones at home, I hardly think I would like to designate that which I think would be the very best dust preventive. I thank you, gentlemen. (Laughter and applause.)

R. H. GILLESPIE (Chief Engineer of Sewers and Highways, Borough of the Bronx, New York City): Mr. Chairman, in the portion of the city of New York with which I am connected, there are about 130 miles of macadam streets, and about 180 miles of dirt roads. Prior to 1910, it was our custom to sprinkle the macadam roads and streets with water and make no attempt to prevent dust on the dirt roads. During the summer of 1910, we started to treat our macadam streets and roads by using dust preventives such as heavy oils. At that time the oils were applied to the streets with the ordinary water wagon, with the result of uneven distribution and additional labor and expense in spreading the oil with hand brooms. Later, however, machinery for the proper distribution of the oil was purchased, so that at the present time little difficulty is encountered in obtaining an even distribution. One half of a street is first oiled, and, after from 24 to 48 hours, is spread with about ¼ in. of torpedo sand. The other half of the street is then treated in the same manner. The results are especially good.

When we first began to apply the oil, there was a general outcry from the residents along the streets that the oil was being tracked into the houses. Today, however, the residents complain if there is any delay in the treatment of the streets on which they reside. Many of the old macadam streets and roads now have a surface appearance very similar to sheet asphalt. On a number of the dirt roads we have used light oils, and an occasional treat-

ment during the summer greatly abates the dust nuisance. I do not know that I have anything further to say on the subject.

H. G. SHIRLEY (Chief Engineer, Maryland State Roads Commission): In considering dust preventives, there are, of course, light oils and heavy oils, but this subject considered in its broader sense would take in any oil that we could apply cold. In Maryland there are a great many roads built of macadam, which had to be treated to preserve them from the automobiles and also to prevent dust. We have just about completed treating 200 miles of this character in the state. These roads were oiled with different products, using, as far as possible, the products that would not only lay the dust, but would bond the surface together. The manner in which this was done was by sweeping the roads clean, getting all the dust off, and then applying the oil and covering it with torpedo gravel, washed gravel, or trap rock varying from 1 in. to ¼ in. in size. This has given very good results. Some of the roads have the appearance of an asphalt surface. The work was done by horse-drawn distributors, under pressure, by a few gravity distributors, and by automobile truck distributors. We have found this is the only way we can preserve our old macadam roads, and keep the surface from raveling, and also keep the dust down. Our people are clamoring and insisting that the roads shall be treated in this way, especially those roads where there is a great deal of automobile traffic. This treatment costs from 1½ to 3 cts. per sq. yd. Barrels of oil of the same character as that applied to the roads are placed alongside of the roads as are also piles of stone chips or gravel, and as soon as a place is broken, it is the duty of the patrolman to pour on a little oil, spread it over with gravel, and tamp it.

Under this system, we have obtained very good results, and would be glad to show any of you gentlemen over our roads in Maryland, if you come down to see us.

MR. GRABILL: At the risk of a little repetition, I want to say just a few words on the subject of dust prevention. It is a subject which is pretty well to the front just now.

When we used water, no matter how carefully we did it, when I got down to my desk every morning, a lot of com-

plaints would come in about the dust. We had, up to three or four years ago, no system of laying the dust except by the water wagon, both for the city and in the suburban districts. Wherever there was a line of water mains in a suburban road, we watered that road. The rest of them had to stay in the dust.

We have now almost abandoned watering as the means of dust prevention both in the city and outside it. Of course, the paved streets are cleaned, and there is no other dust prevention necessary; but the macadam streets, and the streets which are only occasionally cleaned (where the surface is of a temporary nature) are all oiled with emulsion oil which is put on so lightly that it does not affect the foot crossing in the least. That is the reason the emulsion is used. You can't use heavy oil on the city streets because pedestrians can't cross it just as soon as you put it down. Of course, they must be at all times ready for foot travel. Emulsion oil is not objectionable in that respect. This emulsion has to be applied at least each week or ten days, and it is applied, as of course you know, with a mixture of oil in about four parts of water, which by the end of the season provides a sufficient coat to be very apparent, and produces a slight mat, but one that does not protect the road surface.

The country roads we treat just as Mr. Shirley has described, with a heavy oil, except that we do not use very much cold oil now. We use a hot oil, as far as possible, applied under pressure, and we get at that as early in April as possible, and get all of our roads coated once over as quickly as possible with oil applied hot under pressure by a machine which is drawn by the steam roller. This coat, on a heavily traveled road, has to be applied at least twice during the season. Some roads less heavily traveled will require only one coat in the season, and will remain in good conditon. The coat not only prevents the dust, but it prevents a great amount of wear on the surface, and it is the only treatment that is needed for exclusive automobile travel. If you have an exclusive automobile travel it can be handled in that way with very little cost. (Applause.)

WALTER A. EVANS (Director, Board of Freeholders of Essex County, New Jersey): Mr. Chairman, Essex County

has gone through the oil propositions pretty thoroughly. We have 156 miles of macadam roads under our control. In 1909 we started oiling some of those roads. In that year we used about $5,000 worth of oil and made one application on the more heavily traveled parts of the county with so-called asphaltic oil. There was considerable complaint from residents in the neighborhood, of the application of this oil from tracking, etc., but it seemed to meet a certain amount of satisfaction in that they did not have the dust. We made only one application that year. In 1910 we spent in the neighborhood of $15,000 and oiled every mile of road in the county once, when it was found inadequate to entirely suppress the dust during that year. In 1911, we divided the county into districts, and we had become interested in non-asphaltic oils to some extent, so much so, that we took about 60 miles of our roads and gave them non-asphaltic oil treatment as against the balance of the county which was laid with asphaltic oil, and that year we spent $22,000. We oiled all our roads twice during the season. I found that we were perfectly satisfied with the non-asphaltic oil, and that it was the oil to be used in Essex County. It met with general satisfaction from the traveling public, it also met with satisfaction from the residents on the line of the county roads. I may express it in this way. On applying the asphaltic oil it took a longer time for it to penetrate. The oil would naturally go to the pits in the road. If it were laid a little heavier in one place than in another, it took about three days to secure full penetration. We found that with non-asphaltic oil penetration usually took effect thoroughly in anywhere from 18 to 24 hours, according to the temperature. We also found in our experiments that non-asphaltic oil lasted just as long and held the dust, and that if the dust did begin to move before we could get to it with the second application, we did not have the complaints from the residents along the line about the smearing of furniture and causing the paint on the houses to peel. We did have a number of complaints from the residents that the paint on their houses peeled as a result of asphaltic oil dust getting on their houses. This past summer we spent $22,000. I suppose Essex County roads—take them all in all—are probably as heavily traveled roads as any roads

in the country. I might add that Essex County is a very densely populated county. Some of our roads have in the neighborhood of anywhere from 1,800 to 2,800 vehicles a day pass over their surfaces, and from that you will get an idea of the wear of the oil. We have made two applications this season. We started in June and made our last applications between the middle of September and the middle of October. We don't let our oiling work by the square yard. We buy our oil in tank cars. We advertise it, and we receive the bids and have the oil laid so much a gallon on the roads. I think that the benefit of that is that you get all of the advantage as against the contractor's advantage. We specify on the first laying of the oil, 1-5 gal. per sq. yd., and upon the second application between 1-7 and 1-9 gal., as the case may require—some roads take more oil than others.

There is another phase of this proposition that has become very important, and that is resurfacing work. Previously upon resurfacing a road, (I might add as a side light, that our roads are all bonded with clay), on the application of the asphaltic oils we found that vehicles traveling over it removed the bond from the road. We found a large amount of pitting taking place in our roads as the result of that bond being moved, so that we had to discontinue the application of asphaltic oils to recently resurfaced roads. But in 1911 we tried small stretches with the non-asphaltic oil and found we had no trouble with the situation. It took a little bit more oil than it did on the older roads. In 1912, on every bit of resurfacing work that we have completed, we applied non-asphaltic oil within ten days after having dressed the roads with screenings. We find the roads in beautiful condition today; and, I might say, after a day or two of travel over those roads treated with non-asphaltic oil, they pad down. For horse travel we find those roads much better than the roads laid with asphaltic oil, from the standpoint of slipping and skidding. On a hill, especially, it is very bad, from the fact that the horse cannot get a toe grip. As the gentleman from Maryland said, the application of certain good oils will eventually give you an almost asphaltic surface, and Essex County is essentially a hilly county. We found a great deal of trouble with the asphaltic con-

ditions of our hills. We found none of that condition with the use of the non-asphaltic oil. I thank you. (Applause.)

[There being no further discussion the session and the convention were declared to be adjourned.]

LIST OF EXHIBITORS

Commercial

Acme Road Machinery Co., Frankfort, N. Y.
Adams & Co., J. D., Indianapolis, Ind.
American Asphaltum & Rubber Co., Chicago, Ill.
American Assoc. of Creosoted Wood Paving Mfrs., Chicago, Ill.
American Culvert Mfg. Co., Buechel, Ky.
American Rolling Mill Co., Middletown, O.
Amies Road Co., Easton, Pa.
Bain Wagon Co., Kenosha, Wis.
Barrett Manufacturing Co., Philadelphia, Pa.
Bausch & Lomb Optical Co., Rochester, N. Y.
"Better Roads," Jamestown, O.
Blome Company, R. S., Chicago, Ill.
Blystone Machinery Co., Cambridge Springs, Pa.
Bucyrus Co., South Milwaukee, Wis.
Buffalo Pitts Co., Buffalo, N. Y.
Burch Plow Works, Crestline, O.
Carey Co., Philip, Cincinnati, O.
Carlyle Paving Brick Co., Portsmouth, O.
Case Threshing Machine Co., J. I., Racine, Wis.
Concrete Guard Rail Co., Rochester, N. Y.
Cressy, Walter, Gloucester, Mass.
Dietzgen Co., Eugene, Chicago, Ill.
Dolarway Paving Co., New York, N. Y.
Doran & Co., Cincinnati, O.
Dunn Wire-Cut-Lug Brick Co., Conneaut, O.
Eagle Wagon Works Co., Auburn, N. Y.
Eureka Machine Co., Lansing, Mich.
Farquhar Co., A. B., York, Pa.
Galion Iron Works Company, Galion, O.
"Good Roads," New York, N. Y.
Good Roads Machinery Co., Kennett Square, Pa.
Guelich Paving Process Co., Philadelphia, Pa.
Harry Brothers Co., Newport, Ky.
Hassam Paving Co., Worcester, Mass.
Headley Good Roads Co., Philadelphia, Pa.
Hetherington & Berner, Indianapolis, Ind.
Huber Manufacturing Co., Marion, O.
Huron Trap Rock Co., Sault Ste. Marie, Mich.
Ingersoll-Rand Co., New York, N. Y.
Kent Machine Co., Kent, O.
Lansing Company, Lansing, Mich.

National Paving Brick Mfrs.' Assoc., Cleveland, O.
National Surety Co., New York, N. Y.
Novo Engine Co., Lansing, Mich.
Ohio Road Machinery Co., Oberlin, O.
Pioneer Tractor Mfg. Co., Winona, Minn.
Portage Silica Co., Youngstown, O.
Republic Creosoting Co., Indianapolis, Ind.
Robeson Process Co., Pennington, N. J.
W. T. Shannon, Cincinnati, O.
Steel Protected Concrete Co., Philadelphia, Pa.
Stevenson & Leonard, Albany, N. Y.
Tarrant Manufacturing Co., Saratoga Springs, N. Y.
Texas Company, New York, N. Y.
Thew Automatic Shovel Co., Lorain, O.
Troy Wagon Works Co., Troy, O.
United Gas Improvement Co., Philadelphia, Pa.
U. S. Asphalt Refining Co., New York, N. Y.
Universal Portland Cement Co., Chicago, Ill.
Universal Road Machinery Co., Kingston, N. Y.
Warner-Quinlan Asphalt Co., Syracuse, N. Y.
Warren Brothers Co., Boston, Mass.
Watson Wagon Co., Canastota, N. Y.
Westrumite Co., Whiting, Ind.
Wheeling Mold & Foundry Co., Wheeling, W. Va.
Yellow Pine Manufacturers' Association, St. Louis, Mo.

National, State, Municipal and Educational

United States Office of Public Roads
State of Connecticut
District of Columbia
State of Illinois
State of Kentucky
State of Maryland
State of Massachusetts
State of New Jersey
State of New York
State of Ohio
State of South Carolina
State of Washington
State of Wisconsin
City of Cincinnati
City of New York
Massachusetts Institute of Technology
Rensselaer Polytechnic Institute
University of Cincinnati
University of Ohio

ANNUAL MEETING

The annual meeting of the Association, as provided for in Chapter I, Section 1, of the By-Laws was held at the Hotel Astor, New York, N. Y., February 7, 1913.

At this meeting officers and directors were duly elected, for which see pages 314 and 315.

The reports of the Executive Committee, the Secretary and the Treasurer were read by the Secretary. They are printed on this page and on the four pages following.

The constitution and by-laws as amended at the meeting are printed on pages 310 to 312, inclusive.

Annual Report of the Executive Committee of the American Road Builders' Association

New York, N. Y., Jan. 27, 1913.

To the Board of Directors of the
American Road Builders' Association.

Gentlemen:—

In accordance with the provisions of Chapter III, Section 8, of the By-Laws, the Executive Committee submits herewith its annual report to the Board of Directors.

Since the last annual meeting 203 new members have been added to the rolls, and there have been three resignations, making a net gain in the membership of 200.

The reports of the Treasurer and the Secretary, which are herewith submitted, indicate that on December 31, 1912, there was a balance on hand of $1,536.94, that there were bills receivable amounting to $1,566 and accounts payable amounting to $1,025.58, leaving a net surplus of $2,077.36. This sum will be sufficient to cover the cost of the printing of the proceedings of the 1912 convention and other incidental expenses prior to the next convention.

The convention held in Cincinnati December 3 to 6, inclusive, was successful in point of number and character both of attendance and exhibits. The success of the convention should be particularly gratifying, and goes far to confirm the judgment of the Board of Directors that it was

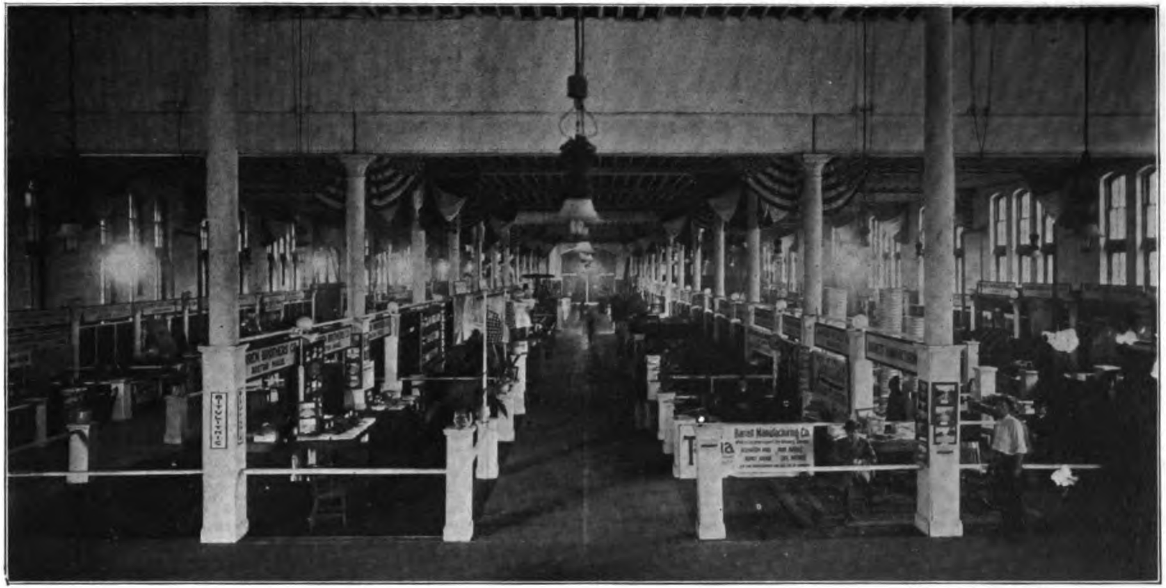
better to hold our own convention and to adhere to our own special line of work, rather than attempt to participate in a joint congress held by a number of different organizations, which, although they may have the same general object, are striving to accomplish that object by very different means.

The official registration at the Cincinnati Convention was 1,303. The number of commercial exhibits was 66, in addition to which exhibits were made by the Federal Government, twelve states, two cities and four educational institutions, a total of 85 different exhibits. The sale of space for commercial exhibits amounted to $5,764.50 while no charge was made for the Federal, State and Educational exhibits, and the cost of the transportation and installation was met by the Association. These displays as a whole were not only unusually attractive, but had an educational value which it would be difficult to overestimate.

The routine work of the Association has been conducted by the Secretary, with the assistance of one stenographer, whose salary has been paid by the Association. The demands upon the time of the Secretary have been more than it is proper to ask without compensation, and your Committee regrets that the finances of the Association are not such as to permit the employment of a properly paid clerical staff.*

Your Committee believes that the present method of nominating officers is not entirely satisfactory. The requirement that three names be presented for each office unavoidably results in some cases in placing especially desirable candidates in opposition to each other, and your Committee has prepared, and submits herewith, a draft of amendments to Chapters I and II of the By-Laws, providing for increasing the Nominating Committee to seven (7), not more than two of whom shall be residents of a single state. It also provides for the presentation of one name for each office to be filled by this Committee, with proper provision for independent nominations by any ten (10)

*In the above report, E. L. Powers stated that he could not approve that portion reading as follows:
"The demands upon the time of the Secretary have been more than it is proper to ask without compensation, and your Committee regrets that the finances of the Association are not such as to permit the employment of a properly paid clerical staff."



GENERAL VIEW OF COMMERCIAL EXHIBITS AT THE FOURTH ANNUAL EXHIBITION OF ROAD MAKING MACHINERY, MATERIALS AND APPLIANCES—CINCINNATI, O., DEC. 3-6, 1912.

members, the names of all candidates for each office to be arranged alphabetically on the ballot, so that there shall be no discrimination between those named by the Committee and those who may be nominated independently. This change in method makes it desirable to fix the date of the annual meeting one month later.

We also suggest certain minor amendments to Chapter III of the By-Laws, which now specifically fixes the time at which certain reports shall be made, and which requires the printing of the reports of the Board of Directors, the Secretary and the Treasurer, and the sending of the same to all members of the Association ten days before the annual meeting. Inasmuch as these reports will be printed with the proceedings of the annual conventions, we believe that the expense of a separate printing and mailing could be saved, while they serve no useful purpose.

Your Committee has given serious consideration to the feasibility of the establishment of state or other local associations to be affiliated with the general Association. The most difficult problem which would be presented in the organization of such local associations would be the division of the dues to be paid between the local and the general associations. Our dues are now so small that if the members of local associations were to contribute less than the regular dues, they could not be furnished with copies of the proceedings and other matter issued by the Association except at a loss, while it is probable that many of our members might identify themselves with such local associations and forfeit their present membership in the general Association. We would recommend that the new Board of Directors give serious thought to the feasibility of the establishment of such local associations.

Respectfully submitted,
EXECUTIVE COMMITTEE,
(Signed)
Nelson P. Lewis.
Fred. E. Ellis.
E. L. Powers.

Secretary's Report

December 31, 1912.

To the Board of Directors,
American Road Builders' Association.

Dear Sirs:—

I have the honor to present a statement of receipts and disbursements of the Association for the year from December 31, 1911, to December 31, 1912. I also submit herewith a general balance sheet showing the condition of affairs of the Association:

RECEIPTS		DISBURSEMENTS	
1912		1912	
Jan. 1, Cash on Hand	$76.00	Moneys sent to Treasurer Crosby Jan. 1st to Dec. 31st	$4,774.05
Receipts for Exhibition Space	4,495.50	Dec. 31st, Cash on Hand	376.56
Membership Dues	568.00		
Sundries	1.26		
Interest	9.85		
	$5,150.61		$5,150.61

GENERAL BALANCE SHEET.

December 31st, 1912.

ASSETS		LIABILITIES	
1912		1912	
Dec. 31st, Cash on Hand, Treasurer	$1,160.38	Dec. 31st, Accounts Payable	$1,025.58
Cash on Hand, Sec'y.	376.56	Surplus	2,077.36
Due from Exhibitors.	1,494.00		
Membership dues for 1912 unpaid (billed)	72.00		
	$3,102.94		$3,102.94

(Signed) E. L. POWERS,
Secretary.

Treasurer's Report

January 1st, 1913.

To the American Road Builders' Association,

New York, N. Y.

Gentlemen:—

As required by Section 6, Chapter III, of the By-Laws, I herewith submit my report as Treasurer for the year 1912:

Balance on hand January 1st, 1912:		
In Corn Exchange Bank, New York......	$342.80	
In Essex National Bank, Montclair, N. J.	871.82	
In hands of Treasurer..................	120.50	
		$1,335.12
Received from current sources January 1st, 1912, to December 31st, 1912..............................		4,774.05
Total		$6,109.17
Paid Audited Vouchers for current business January 1st to December 31st, 1912........................		4,948.79
Balance on hand December 31st, 1912...........		$1,160.38
In Corn Exchange Bank, New York..........	$927.95	
In Essex National Bank, Montclair, N. J.....	264.43	
	$1,192.38	
Less Checks not returned..............	32.00	
		$1,160.38

Respectfully submitted,

(Signed) W. W. CROSBY,

Treasurer, A. R. B. A.

AMERICAN ROAD BUILDERS' ASSOCIATION

Constitution

ARTICLE I.

Name.

This Association shall be known as the American Road Builders' Association.

ARTICLE II.

Seal.

The official seal shall be circular in form and bear the words "American Road Builders' Association Corporate Seal 1910."

ARTICLE III.

Location.

The headquarters of the Association shall be located in the City of New York, New York.

ARTICLE IV.

Objects.

The objects for which this Association is organized are to acquire and disseminate information concerning highway construction and maintenance in the States and Cities of the Union and in the Provinces and Cities of Canada; to stimulate interest in the subject and to promote educational, legislative and other measures tending to their accomplishment.

ARTICLE V.

Membership.

Section 1. The Association shall have five (5) classes of members, viz., active, associate, honorary, contributing and life members.

Sec. 2. Active members shall be persons who are actively engaged in laying out or supervising work of construction and maintenance of highways and streets and those interested in highway development. Active members shall be elected in accordance with the by-laws adopted by the Association.

Sec. 3. Associate members shall consist of societies or other organizations interested in the objects of the Association.

Sec. 4. Honorary members shall be those who have performed distinguished service in the cause of highway extension and improvement. They shall be nominated by the Board of Directors and elected by the Association.

Sec. 5. Contributing members shall be commercial bodies who contribute one hundred dollars ($100.00) per year.

Sec. 6. Life members shall consist of active or associate members making a payment of five hundred dollars ($500.00) upon their election to membership.

Sec. 7. Only active members shall vote or hold office.

ARTICLE VI.

Officers.

Section 1. The officers of this Association shall be selected from its active membership and shall consist of a president, three vice-presidents, eighteen directors, a secretary and a treasurer, who shall constitute a board of directors, from which shall be elected an executive committee of three, one of whom shall be the secretary of the Association.

Sec. 2. The President, Vice-Presidents, Secretary and Treasurer shall be elected for one year. Six Directors shall be elected each year to serve for three years, except that at the first annual meeting after the adoption of this Constitution six directors shall be elected for three years, six for two years and six for one year.

ARTICLE VII.

Sections.

For the purpose of carrying on the work of the Association, sections may be established in as many of the States of the

Union and Provinces of Canada as may seem desirable. Each section shall be presided over by an active member of the Association.

ARTICLE VIII.

By-Laws.

By-laws for governing this Association shall be made by the Board of Directors, subject to the approval of the active membership of this Association.

ARTICLE IX.

Amendments.

Section 1. An amendment to this constitution shall first be proposed by at least five (5) active members and submitted to the Board of Directors, a majority of which shall approve before the amendment, with letter ballot, is sent to the active members of the Association.

Sec. 2. Amendments may be adopted only at any regular or special meeting of the Association, provided that a notice of such meeting, including the proposed amendment and a letter ballot shall have been sent to each member of the Association thirty (30) days before said meeting. An affirmative vote of three-fourths of all ballots cast shall be necessary for the adoption of any amendment.

By-Laws

CHAPTER I.

Meetings.

Section 1. The annual meeting of the Association for the election of officers and the transaction of business shall be held on the first Friday in February of each year. Conventions of the Association for the reading and discussion of papers, social intercourse and reports of committees, shall be held at such times and places as the Executive Committee may determine, subject to the approval of the Board of Directors.

Sec. 2. Special meetings may be called by the Board of Directors or may be called on the request of thirty (30) active members, which request shall state the object of the meeting. Notices of such meeting shall be sent out ten (10) days in advance and no other business be considered than that stated in the notice.

CHAPTER II.

Election of Officers.

Election of officers shall be as follows: At the Fall convention a nominating committee of seven (7), not more than two (2) of whom shall be residents of a single state, shall be chosen by the Association, and this committee shall submit to the Secretary within three (3) weeks the names of not less than one (1) or more than three (3) candidates for each office to be filled. Letter ballots shall be then sent by the Secretary to each active member at least thirty (30) days before the date of the annual meeting stating the hour at which the polls will close. The ballots shall be returned to the Secretary enclosed in two envelopes, the inner one to be blank and the outer one endorsed with the signature of the active member voting. Two tellers shall be appointed by the President, and the result of the ballots shall be announced at the annual meeting. The candidate having the largest number of legal votes by letter ballot shall be declared elected.

In case of failure to elect an officer on account of a tie vote, the meeting shall proceed to ballot for such office, the choice of candidates being limited to the persons so tied. Vacancies occurring in any office may be filled by the Board of Directors at any meeting provided notice of such vacancy shall be sent to each member of the Board at least ten (10) days before such meeting. A majority of the votes cast shall be necessary to elect.

CHAPTER III.

Duties of Officers.

Section 1. The President shall be the presiding officer at all meetings of the Association, and shall perform the duties usually devolving upon such officer. The President shall be ineligible for re-election for one year.

Sec. 2. The First Vice-President shall, in the absence of the President, preside at the meetings of the Association, and in the disability of the President shall perform the duties of the President.

Sec. 3. The Second Vice-President shall, in the absence of the President and First Vice-President, preside at the meetings of the Association and perform the duties of the President.

Sec. 4. The Third Vice-President shall, in the absence of the President and First and Second Vice-Presidents, preside at the meetings of the Association and perform the duties of the President.

Sec. 5. The Secretary shall keep the records and complete reports of the proceedings of the Association, and shall conduct all necessary correspondence connected with the affairs of the Association. He shall notify all members who are in arrears in dues and shall attend to such other affairs of the Association as fall particularly to his office, and such other duties as may be placed upon him by the Board of Directors. At the annual meeting of the Association, the Secretary shall make a written report of the work, and shall also make such special reports to the Board of Directors as it may require from time to time. He shall draw all vouchers on the Treasurer for the payment of money.

Sec. 6. The Treasurer shall hold in safe keeping, in a bank designated by the Board of Directors, all the moneys paid to the Association, and shall expend same only in the payment of vouchers duly drawn by the Secretary and approved by the President or such general officer as may be designated by him. He shall keep an accurate account of receipts and expenditures, and shall make a written annual report at the annual meeting of the Association. He shall submit his annual report to the Board of Directors on or before the second Friday in January. If required by the Board of Directors, the Treasurer shall file a bond in such amount as may be required.

Sec. 7. The Board of Directors shall have the general management of the affairs of the Association as trustees, in conformity to the laws under which the Association is organized and the provisions of the constitution. It shall direct the investment and care of the funds of the Association, make appropriations for specific purposes and take measures to advance the interests of the Association. The Board of Directors shall make an annual report at the annual meeting, and shall transmit the report of the Secretary and Treasurer and other officers and committees. These reports shall be printed and sent to the members of the Association at least ten (10) days before the annual meeting.

Sec. 8. The Executive Committee shall exercise a general supervision over the affairs of the Association. It shall report annually to the Board of Directors the condition of the Association and recommend any measures which seem advisable to adopt for the best interests of the Association. The Executive Committee shall also have such other powers as may be given it from time to time by the Board of Directors.

CHAPTER IV.

Election of Members.

Applications for membership shall be made on forms provided by the Association and endorsed by one active member and shall be acted upon by the Executive Committee. Upon the approval of the Executive Committee and payment of the required dues, the applicant shall become a member.

CHAPTER V.

Dues.

Section 1. The annual dues for active members of the Association shall be two dollars ($2.00), payable in advance.

Sec. 2. The annual dues for associate members shall be ten dollars ($10.00), payable in advance.

Sec. 3. Annual dues for contributing members shall be one hundred dollars ($100.00), payable in advance.

Sec. 4. Dues shall be due and payable January 1st of each year.

Sec. 5. Neglect to pay dues for six months after notification by the Secretary shall be sufficient cause for the removal of the member's name from the roll by the Executive Committee without further notice.

CHAPTER VI.

Quorum.

Section 1. Five directors shall constitute a quorum at any regular or special meeting of the Board of Directors.

Sec. 2. Fifteen active members shall constitute a quorum at any regular or special meeting of the Association.

CHAPTER VII.

Congresses.

If it shall be deemed expedient to hold a congress of road builders in connection with any of its conventions, no action that such congress may take shall be binding upon the American Road Builders' Association, except the Association shall vote to be so bound.

CHAPTER VIII.

Amendments to By-Laws.

These by-laws may be amended, revised or changed by the Board of Directors, subject to the approval of the voting membership at its next regular meeting. Emergency changes may be made temporarily effective by the consent of the majority of all the members of the Board, but such changes shall only be effective until the next meeting of the Association, when it shall be voted upon by the Association.

OFFICERS 1913

President
SAMUEL HILL
President, Washington State Good Roads Association

First Vice-President
HAROLD PARKER, M. Am. Soc. C. E.
Ex-Chairman, Massachusetts Highway Commission

Second Vice-President
W. A. McLEAN
Provincial Engineer of Highways of Ontario, Canada

Third Vice-President
GEORGE W. TILLSON
Consulting Engineer, Borough of Brooklyn

Secretary
E. L. POWERS
Editor "Good Roads"

Treasurer
W. W. CROSBY, M. Am. Soc. C. E.
Consulting Engineer

DIRECTORS

TERM EXPIRES 1916

WM. H. CONNELL, Assoc. M. Am. Soc. C. E.
Chief, Bureau of Highways and Street Cleaning of Philadelphia

T. COLEMAN DU PONT
Pres., E. I. du Pont de Nemours Powder Co.

C. A. KENYON
President, Indiana Good Roads Association

NELSON P. LEWIS, M. Am. Soc. C. E., Chief Engineer, Board of Estimate and Apportionment of New York City

R. A. MEEKER
State Highway Engineer of N. J.

LOGAN WALLER PAGE, M. Am. Soc. C. E.
Director, U. S. Office of Public Roads

AMERICAN ROAD BUILDERS' ASSOCIATION

TERM EXPIRES 1915

A. W. DEAN, M. Am. Soc. C. E.
Chief Engineer, Massachusetts Highway Commission

S. D. FOSTER, Assoc. M. Am. Soc. C. E., Chief Engineer,
State Highway Department of Pennsylvania

P. L. HARDISON
State Highway Commissioner of Maine

FRANK D. LYON
Ex-Deputy Commissioner of Highways of New York

W. J. ROBERTS, M. Am. Soc. C. E.
State Highway Commissioner of Washington

CLIFFORD RICHARDSON, M. Am. Soc. C. E.
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CHARLES HENRY DAVIS, M. Am. Soc. C. E.
President, National Highways Association.

JOHN R. RABLIN
Chief Engineer Metropolitan Park Commission of Boston

CHAS. P. PRICE, Assoc. Am. Soc. C. E.
Manager, American Tar Co.

ARTHUR H. BLANCHARD, M. Am. Soc. C. E.
Professor of Highway Engineering, Columbia University

Executive Committee

G. W. TILLSON

R. A. MEEKER

E. L. POWERS

PROCEEDINGS

OF

THE TENTH ANNUAL CONVENTION

OF THE

American Road Builders' Association

Held at Philadelphia, Pa.
December 9, 10, 11 and 12, 1913
together with
Reports of the Executive Committee, Secretary and Treasurer
Presented at the Annual Meeting, February 6, 1914
List of Members, etc.

Price, Two Dollars

Published by the Association
150 Nassau Street
New York

The Association

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E. L. POWERS

The Fourth American Good Roads Congress and Tenth Annual Convention of the American Road Builders' Association, and in conjunction therewith, the Fifth Good Roads Show, were held at Philadelphia, Pa., on December 9, 10, 11 and 12, 1913.

The total registration was 3,171, this including representatives from practically all of the states of the Union, the District of Columbia and Canada. The attendance was the largest ever registered at a road convention in the United States, and also included a larger number of those actively engaged in highway work. The two classes whose attendance at the Cincinnati convention was especially noticeable —engineers and officials of city street departments and contractors—were present in even larger numbers at Philadelphia.

The proceedings of the convention were divided into eight sessions. The first session and part of the second were devoted to addresses of welcome and to a response on behalf of the A. R. B. A. The others, except the sixth, were devoted almost entirely to the presentation and discussion of technical papers. The sixth session, on Thursday evening, was a public meeting, at which the addresses were principally non-technical. All of the sessions, except the sixth which was held at the Bellevue-Stratford Hotel, were held at the First Regiment Armory.

On Wednesday evening, A. R. B. A. members and exhibitors were guests of the citizens of Philadelphia at the theater, and on Thursday afternoon the delegates and guests were taken on an automobile inspection trip by the Philadelphia Bureau of Highways. The trip included inspections of roads and streets completed and under construction in and near the city and the service test roadway on the Byberry and Bensalem Turnpike.

The Fifth Good Roads Show was participated in by 115 exhibitors, of which 100 were commercial. The non-commercial exhibitors comprised eight states, one territory, one Canadian Province, two cities, two universities and one government bureau. Most of the commercial exhibits were displayed in the main drill hall of the First Regiment Armory. Some of the heavier commercial exhibits were displayed in the tent near the Armory and in the open. The governmental and educational exhibits were shown in the smaller drill hall in the Armory.

Proceedings
of the
Tenth Annual Convention

FIRST SESSION

Tuesday Afternoon, December 9

President Samuel Hill: Gentlemen, please take your seats; the Convention will please come to order. His Excellency, the Governor of the State, has been detained but will be here at 2.30 this afternoon. In the meantime we have the pleasure of having with us at this meeting, the representative of the Mayor of the city of Philadelphia, the acting Mayor, Mr. George D. Porter, and on his card I see the inscription, "Department of Public Safety." I am very glad indeed to see that; it assures us at least that we are in good hands.

I take pleasure in presenting to you the acting Mayor of the City, Mr. George D. Porter. (Applause.)

ADDRESS OF WELCOME ON BEHALF OF THE CITY

By GEORGE D. PORTER
Director of Public Safety and Acting Mayor of the City of Philadelphia

Mr. Chairman, Ladies and Gentlemen: I sometimes wonder why it is necessary to call upon the Director of Public Safety to represent the Mayor, usually at gatherings of this kind. I see very orderly people and it is not necessary, as a rule, to call in the Police Department. (Laughter.) But I am not here today as the Director of Public Safety, but as the representative of the Mayor, who, unfortunately, is not able to be here, having been under the weather for some little time.

I have a commission from him to extend to all of you a most hearty welcome to the City of Brotherly Love. We Philadelphians are exceedingly proud of Philadelphia. We are proud of Philadelphia because we believe it to be the most American city in the country. We are proud of it because it is here that nearly every American eye looks at least once a year, and frequently more often, because here we have that priceless relic which all Americans love and which every American, if he comes from beyond the confines of Philadelphia, always takes an opportunity to look up—the old Liberty Bell.

My position does not put me in the enviable position which you men are in, of knowing anything about roads. I am not a road builder. My chief business is to see that the people keep on the straight road. (Laughter.) And I have considerable difficulty in doing that.

We Americans at the present time are taking more notice than ever of the necessity for the construction of decent and permanent roads. Too long have we suffered from neglect in this connection, and all over this great country of ours we are at last waking up to the necessity of developing the roads in order that our great highways may become arteries of commerce as they have not been in the past. We in Pennsylvania have been endeavoring for a number of years to advance the good roads interest, and, for reasons best known to some of our citizens, a bill which made quite possible the construction of good roads in this state was defeated at the last election. Pennsylvania, unfortunately, has not been as advanced as have some of the other states in the matter of road building, but I hope that we are not very far from an opportunity of witnessing in Pennsylvania the same kind of roads that some of our sister states are constructing today. If the average citizen realized the importance of the construction of good roads through his community, it would not take the public long to realize in addition to that, that it meant dollars in their pockets in the enhancement of the value of their real estate and in various other ways.

In Philadelphia, during the last two or three years, we have been making rapid strides in the matter of the construction of good roads. I think that when our committee takes you gentlemen around to show you some of the work done during the past two years, you will be well pleased with it. More good roads have been constructed in Philadelphia during the past two years than in any previous two years in the city's history, and you can depend upon it that they are the kind of roads which will be permanent. In addition to that, the present Director of Public Works has conceived the idea that we must adopt the European system of having these roads patrolled by men who can discover their defects and remedy them before the road has gone to rack and ruin, so that we here in Philadelphia feel that we are making rapid strides toward the goal for which other states and cities have been striving for so many years. And I feel quite sure that before the end of the present administration, Philadelphia will be one of the best paved cities in this great country. (Applause.)

I presume that the committee in charge of this convention has laid out a very elaborate program for you, but I do want to say, on behalf of the city administration, that if there is anything we can do to make your stay a pleasant and profitable one, we shall be glad to have you call on us. It is always customary for the chief magistrate to offer to conventions of this kind, the keys of the city. Philadelphia has no keys and has not had for a long time; instead, we have resorted to the old latchstring, which already hangs outside and which we hope you will use whenever opportunity affords. If Philadelphia can do anything to make your stay here a pleasant and enjoyable one, we certainly want you to call upon us.

We feel that we are a hospitable city, we endeavor to be so; we feel that we have a just cause to be that way because in no city in this country does a greater number of people actually own their homes than right here in Philadelphia. With a population of 1,700,000 people, with 375,000 buildings in it of which 350,000 or thereabouts are dwellings, 60 per cent. of those dwellings are owned by the people who live in them. When those of you who come from beyond the confines of our city are wont to call us slow, it may be all true so far as the number of people are concerned that appear on our highways, especially after eleven o'clock at night. A few weeks ago the Commissioner of Police of New York visited me and I took him to his hotel, and passing along Broad Street he commented on the few people who were on our highways at eleven o'clock, and I said, "Well, one of the things that we are proud of is that all these people in Philadelphia have homes to go to, and if you come with me and gently pull up the blinds in some little home, you will find the family gathered around the fireside, happy in their own associations and not finding the necessity of seeking pleasure on the streets, as elsewhere. But," I said, "as compared with you New Yorkers, you have no homes; you can't find any place to sleep and can't find any place to eat." Therefore, I do say to you that we have, by reason of institutions of that kind, a particular pride in being hospitable to those who come from beyond our borders. I thank you, gentlemén, for the opportunity of being here, and I sincerely trust that the meeting which has been called in this building will not only be profitable to you, but profitable to our city and to our state. I thank you. (Applause.)

PRESIDENT HILL: Ladies and Gentlemen of the Convention, I have just been told by Mr. Powers that I can make only one speech. That is a very great sorrow to me. as I

expected to make a speech now and another in the afternoon also, but he tells me it would be entirely inappropriate, so you will have to wait—of course I know you will wait with great sorrow—until after the Governor of the State comes and makes his speech, before I can respond to the address now given. I will take occasion, however, to announce two committees. They will be as follows:

Credentials: H. G. Shirley, Maryland, Chairman; E. E. Coovert, Oregon; A. T. Laing, Toronto, Ontario, Canada; R. A. Meeker, New Jersey; G. A. Nelson, Alabama; Harold Parker, Massachusetts; F. C. Pillsbury, Massachusetts; E. L. Powers, New York.

Resolutions: F. F. Rogers, Michigan, Chairman; C. J. Bennett, Connecticut; F. W. Buffum, Missouri; J. N. Carlisle, New York; G. W. Cooley, Minnesota; John Craft, Alabama; T. J. Ehrhart, Colorado; N. Vermilyea, Ontario, Canada; W. O. Hotchkiss, Wisconsin; S. P. Hooker, New Hampshire; E. A. James, Ontario, Canada; A. N. Johnson, Illinois; C. M. Kerr, Louisiana; E. A. Kingsley, Arkansas; James R. Marker, Ohio; T. H. MacDonald, Iowa; J. Hyde Pratt, North Carolina; R. J. Potts, Texas; Wm. D. Sohier, Massachusetts; E. A. Stevens, New Jersey; Paul D. Sargent, Maine; Sidney Suggs, Oklahoma; R. C. Terrell, Kentucky; James Wilson, Delaware; A. D. Williams, West Virginia; E. J. Watson, South Carolina.

The Chair will now entertain a motion to adjourn until 2.30, when the Governor will be present and supplement the remarks made by the acting Mayor of Philadelphia.

SECOND SESSION

Tuesday Afternoon, December 9

PRESIDENT HILL: Please be seated, gentlemen. Gentlemen, it is my great pleasure to present to you the distinguished Governor of the Keystone State of Pennsylvania. (Applause.)

ADDRESS OF WELCOME ON BEHALF OF THE STATE

By JOHN K. TENER
Governor of the State of Pennsylvania

Mr. Chairman and Members of the Road Builders' Association: You are here today as the guests of the city and the citizens of Philadelphia, the first city of Pennsylvania. You come from throughout our state, from other states of the nation and from

beyond our borders, and you come to exchange views, to take counsel with each other in that which pertains to roads and road building, the question which, to my mind, is of the greatest material benefit not only to our citizens here but to people of all the world. And so your coming, your conference, your meeting and all that it means, is of vital importance, and not only will the press of this city but the press of the country be most interested in what you do and what you say, and I sincerely hope that the importance of your meeting here will impress itself upon you so that, in the work that is before you, considering the road matters which you will consider, you will do so along practical lines.

What we need, to my mind, more than anything else, is to be told by those who know just what should be done, and not listen to the idealist and the theorist who cannot put his ideas into practice and make them of real, practical good to us. (Applause.)

I realize, also, that you come—you engineers, you scientists, you builders, those of you interested in this great subject—from other states and other climes, and when you come to Pennsylvania, suggesting how roads should be built and that we may learn of you, I hope you will take into consideration when you give us advice—and we want it—that we have a state here with an area of some 450.000 square miles, that we have a population of 8,000,000 scattered over the state, not centered in one great populous community. Philadelphia, this, our first city, is not only our first city in wealth and area, but in population. We have in the other end of the state a very large city which, should it organize as Philadelphia has done, making the city and the county coextensive, would have a population almost as large as that of Philadelphia. And we have a number of great cities, of populations running from 50,000 to 100,000 all over our state, and so you will realize that the traffic is great in every corner of this commonwealth, and that, in the type of roads we build, we must consider that great traffic as well as the heavy burden to be carried by the trucks or the teams as the case may be. Pennsylvania also is, in its physical or geological aspect, you might say, a rugged, mountainous, hilly state. So we cannot, as in more favored portions of the country, scrape up the right of way from each side and build a road in the center and call it a road; but we must take into consideration our mountain paths, our heavy grades, our climatic conditions and the wear and tear on that road, and I hope that from you

gentlemen we shall learn more of what should be done here in Pennsylvania in practical road making.

We have endeavored to create. We have endeavored to not only advise the building of good roads in the state, but we have outlined a comprehensive plan for that undertaking, so that, of all the roads of the state, aggregating a mileage of some 97,000, we shall form a network of the principal roads or arteries and connect all our county seats and provide such a system of roads as will be of the greatest benefit to the greatest number of our citizenship, and so that these roads—such a network of roads and such a system of roads—shall be constructed and maintained by the state. That is the commitment of the state to her people, and our Highway Department is engaged upon the building and must maintain some 8,800 miles of such a system of roads.

From the very founding of our state until the present time or a year ago, this work, in the main, was left to local undertaking and to the local authorities, and notoriously Pennsylvania had very poor roads. Our roads today are not all they should be, and yet it is undeniably a fact that our roads today are better than they have ever been in the history of our commonwealth; and we believe that this should be a state undertaking and that the state should commit herself to such an undertaking. So you may look with confidence in the future to the fact that the roads in Pennsylvania will be better and much better than they have been in the past and will be cared for in a systematic, proper manner. (Applause.)

I want to join, on behalf of the state, the good citizens of Philadelphia whose guests you are today in extending to you a very, very cordial welcome and express my pleasure, for the state, that you come here to hold this most important conference. I sincerely trust it will result in benefit, not only to yourselves, but to all of us. I thank you. (Applause.)

PRESIDENTIAL ADDRESS

By SAMUEL HILL

President of the American Road Builders' Association

With more than ordinary personal pleasure I respond to the cordial greetings extended to us by the City of Philadelphia and the State of Pennsylvania. I say "personal" because thirty-eight years ago at the hands of Mr. A. J. Cassatt, who, in conjunction with his duties as Vice Presi-

dent of the Pennsylvania Railroad, had assumed the duties of pathmaster, I received my first instruction in road building. The open-hearted cordiality with which Philadelphia and Pennsylvania have always received those who come to them as strangers has contributed in no small degree to making everyone who comes always remain a friend. I again say I am personally gratified because I am responding on behalf of an organization of patriotic and intelligent citizens, the like of which is seldom seen assembled together, and which yields to no other body of men in its broad patriotism, its love of country and its desire for the benefit of mankind.

Your association, animated by the spirit of its first president, adding to its numbers year after year as time passed on, men from every section of the United States and Canada whose sole purpose was and is to make pleasant paths for weary feet, assembles for its tenth meeting today. Other associations may and do seek in honorable ways for the advancement of their own interests and that of their fellow-kind; but this organization seeks to serve and to aid every man, woman and child within the borders of the United States and Canada without regard to race or creed.

Turning then from the acknowledgment of the courtesies so gracefully extended to us by our hosts, the Association will pardon me if for a moment I try to point out what should, to my mind, be the distinguishing characteristics of this, our tenth annual convention. No similar body of men representing so wide an area throughout which the English language is spoken has ever been assembled to discuss the question of road transportation. Whether the problem be considered as one to be solved under the stars and stripes or under the union jack, the organization for the maintenance and construction of roads will find its source of income coming from one of four channels: Money by gift or grant; money from direct taxation; money from deferred taxation through the issuance of bonds, or the utilization of labor of those confined for infraction of the laws.

Yet we may have vast sums of money in hand, an army of laborers, and still have, as the result of our efforts, no roads.

To effectuate the purposes of this congress there must be education of two kinds: First of all, the education of the public that they may see the importance of putting this work in the hands of men competent to carry out their allotted tasks; second, in every agricultural college throughout the United States and Canada—and generally, as well,

in the larger institutions of learning—there should be courses of instruction provided where students could be taught road building and highway engineering on the broadest lines.

We do not claim to have yet found the road perfect in any of its details. We do claim to have assembled among our numbers the men in the United States and Canada best qualified to speak on the subject of road building—the men having not only practical training but who have received their education in that greatest, strictest and most exacting of all schools, the school of experience.

I have little time for the peanut policy of the practical politician who talks about trade routes from market centers, who has adopted the ideas of those transportation companies who are quite willing to see all highways radiate from the several localities where the produce of the land when assembled will give them the most economical haul.

Either Canada and the United States each represents a unit, or they do not represent units. If each represents a unit it is undoubtedly to be developed as a whole and as a distinct proposition. All of the country is here now that ever will be here. These several lines of traffic now and hereafter to exist can be determined with reasonable accuracy, and a plan for national highways in both countries, linked together and joined at proper intervals, is a subject which can and should, in my opinion, be considered by the statesmen and governments of both nations.

During this convention each of you will meet men from whom much can be learned. I have never attended a road convention here or abroad that I did not carry away with me new ideas, and that I did not feel grateful for the generous way in which the knowledge obtained by long study, hard knocks, and sometimes ungenerous criticism was imparted to anyone who chose to ask.

Coming as I do from the far away state of Washington you will pardon me if for a moment I tell you of the Pacific Highway Association, of which I have the honor to be president, which contemplates within a reasonable time, say by 1915, a highway from British Columbia traversing the states of Washington, Oregon and California, to the Mexican line. The ultimate ambition of Mr. A. E. Todd, of British Columbia, from whose brain this idea first came, seems to assure us of a line of road from the Arctic to the Antarctic circle. Again, I deplore that attitude of mind which seeks to array class against class in America, and which falsely pronounces that the interests of the user of the road for pleasure are not the same as those of the user of the high-

way for the transportation of farm products. As a member of the National Grange, as one whose home is on the farm, I wish to say that the votes which have carried road legislation in Washington and in Oregon have been those of the tillers of the soil.

Just what steps should be taken to determine the kind of legislation which should be placed on the statute books of Canada and of the United States for the construction of national highways, some of the men composing this convention will sooner or later be called upon to determine.

The year of 1915 will mark a period of one hundred years of peace between the United States and the great British nation. The choicest jewel in the crown of the British Empire, fair Canada, lies on the north of the United States, separated from us only by an imaginary line; and the cordial greetings and hearty hand clasps which the people of each nation give to the other exemplified by the presence here today of so many from Canada are evidence of the deep and sincere regard and esteem in which each nation holds the other, and give rise to the belief held by all thinking men that the destinies of this continent can best be worked out by two separate nations under separate forms of government but united in all that makes for the progress of the world and mankind.

And in commemoration of that peace there should be some outward memorial established that our children and our children's children shall remember the principles which guided and actuated their fathers and which they in turn should hand on unsullied to their descendants. If the Dominion of Canada and the United States should see fit to join in the erection of such memorials at the boundary line across the American continent at such suitable points as may be determined where highways pass between the nations, I believe a service will be rendered to those countries, and to the world at large. To the erection of such memorials many prominent Canadians have given cordial indorsement, and Secretary of State Bryan has authorized me to state to this convention that the same meets with his hearty approval.

In conclusion, I wish for you at this meeting that interchange of ideas, that discussion of methods and principles of road construction, which will result in the advancement of the cause we all have so much at heart.

PRESIDENT HILL: Gentlemen, the first subject to engross your attention you will find on the program today on

the third page, the afternoon session—Subject A, Organization: "Highway Officials, their Duties and Powers." First a paper will be read by Colonel E. A. Stevens, Commissioner of the Department of Public Roads of New Jersey. Will Colonel Stevens please step forward. Gentlemen, Colonel Stevens. (Applause.)

COLONEL STEVENS: Before beginning this paper I would say that there has been a slight misunderstanding as to the subject. This is all I've got to give you, so I will have to give you this. It hardly treats the subject as mentioned in the program quite satisfactorily.

HIGHWAY OFFICIALS, THEIR DUTIES AND POWERS

By COL. E. A. STEVENS

State Highway Commissioner of New Jersey

In some communities, where adequate study has not been given to the policy and economical results of road improvement, it may still be necessary to argue the cause of good roads. The condition of the public roads, however, today is generally admitted as a good measure of a community's advance in civilization.

This condition depends upon two factors: First, correct planning, design and construction; and, second, proper upkeep. Both of these are in turn dependent on efficient administration. In the latter term are to be included all of the numerous details of management, exclusive of the technical engineering work. Without proper administration no extensive system of good roads is possible or even conceivable. It is in this very aspect of the road question that we are most backward. As a pioneer nation we have had to combine many trades in one man. The tradition of those days hangs around us still. We still act on the principle that any two-handed man who can earn a living and is fairly honest can care for a road and that the highway engineer is an almost superfluous luxury whose duty is mainly drawing pretty but useless pictures of work and whose service and pay should be cut down to the irreducible minimum. The engineer—and by this I mean the good and consequently well paid engineer—is essential to good roads; you can't build them and have them stay built without his aid.

Our misapplied inheritance from a glorious past does not limit its baneful influence to the engineer and to his work. In this respect, however, it is losing force every day. We too often spend state money in building magnificent roads without taking any thought of their administration after

completion. In New Jersey, and in many other states, we turn over these roads to elective bodies of constantly changing politics and personnel, bodies not fitted by training for the technical work of administration, without requiring the employment of trained men and without setting any required standard of maintenance. At best these bodies are unconnected units and their work is not systematized and coordinated to a common end.

Whatever may have been the case twenty years ago, the motor vehicle and its ever growing commercial importance today demands continuous roads. The condition of every part of such a road is a matter of general concern and not to be localized, as it is, by the neglect of any portion of what must be a continuous whole if the value of the investment is to be realized.

While this statement is true as to all public roads, its importance is greatest in the case of those roads which form the main arteries of road traffic. These will naturally cross municipal and county boundaries. The cost of the upkeep of any portion within one municipality bears no close relation to the benefit to the community nor to its financial ability. At the same time in the case of less important roads the benefit accrues largely to the locality. Hence it becomes advisable to classify roads so as to provide equitably for the distribution of the cost of maintenance. In whatever manner this classification is made and whatever system of administration is adopted, certain underlying principles must be adopted if the best results are to be expected.

1. There must be a central control to secure the direction of all efforts to a common end.

2. There must be an adequately trained force to carry on the work.

3. Sufficient means must be provided for the work.

As to the first of these principles, whether there be a system of state highways or whether localities are left in charge of their own roads, some one must lay out the through lines and there must be some uniformity in their design and improvement as well as in the condition in which they are to be maintained. These cannot be left to the chance agreement of a number of municipalities. Work both in construction and repair must be planned not only with foresight and intelligence but to give the best results for the state at large and not merely for the convenience and benefit of the locality in which the road is to be built. For the purposes of scientific design statistics as to traffic over various types of roads and the comparative cost of the maintenance under

varying conditions of load must be gathered, compiled and analyzed. New types of construction must be tested and proved. All of this is work which local bodies are seldom fitted to perform even were their means and the value to them of the data obtained sufficient to justify the considerable expense involved.

The need of a trained and disciplined force is beyond doubt. How it is to be secured is the question. The most important men will be those at its head and these naturally will be engineers. Highway engineering in its theoretical requirements is simple enough. Except as to bridges few problems arise requiring high mathematical training. There is, however, an almost unlimited field for the application of the thoroughly digested information that comes only with extended experience. The power to acquire, digest and systematically apply this information is what makes the practical engineer, such as is needed in highway work. This training is best acquired on the work itself by young men with thorough technical preparation. The ideal road force must attract such men, must offer them a training and a future. Only in a large force, free from political control and with fair chances for promotion as reward for proven efficiency, can such conditions be insured. What is true for the technically trained young man is likewise true for the repair man. All officials actually in charge of roads, no matter how important or unimportant their tasks, should form parts of a trained force, without consideration of whether they be employed by township, county or state. Too much stress cannot be laid on the need of a trained force. To every state official will, I believe, at once occur many instances of waste by improper repair, of petty graft and of stupid or ill-planned work. Without a force which at least is supposed to be trained, it is hard, if not impossible, to enforce that individual responsibility which must underlie any efficient administration. The roads also are one system. The driver knows no difference when he passes from a state highway to a township road. Good roads are needed under all jurisdictions if the commercial potentiality of any general highway system is to be developed. Hence the coordination and unity not only in the state force but in all officials charged with providing efficient road service for the people of any state. Today the civil service system seems the only means of recruiting such a force. Whatever may be the shortcomings of this source of supply, it is preferable to political control.

Promotion for efficiency in all grades is necessary for the best results.

Above all any force must have a spirit of loyalty, of devotion to its work and of pride therein; in a word an "esprit de corps." With this, men far from ideal in attainment and organization can and will accomplish results impossible to the most perfectly fitted and organized body not animated by this life-giving force.

A road program must comprise not only a list of the roads to be built and kept in repair and the organization of a force to do the work, but must consider likewise the amount of money needed and the methods by which it is to be raised, and the coat must be cut to fit the cloth. As it is generally the case that the state shares with communities in the cost of much of the road work, the question of finance is not usually to be solved by merely determining the amounts to be furnished each year by the state. The ability and willingness of the counties and municipalities to bear their share must be weighed. At best this is a hard and unsatisfactory problem, but it must be faced and solved, in each case probably by different means and in different ways as local conditions and laws may require.

For any public body the choice of the bond issue to provide for original improvement or of the "pay as you go" method or some combination must be made. The elements in this choice are the comparative cost to the taxpayer and the return to the public in road service. My own experience is that these are seldom considered. The decision is usually based on the desire of finding the easiest way out of a difficult dilemma, satisfying the demand for good roads and keeping down next year's tax levy. The troubles of the officials in charge thirty years hence rarely worry one very much.

I have worked out an example as follows:

Take a case involving $10,000,000 in bonds, issued at the rate of $1,000,000 a year for ten years, bearing 4 per cent. interest and due 30 years from date of issue, with a sinking fund charge of 1.783 per cent.; assume that 100 miles of road will be built each year; that the contractor will keep the road in repair for one year after acceptance and that the cost in repair thereafter is $500 a mile. The last bonds will be paid in forty years. The cost to the community will be,

Sinking fund (construction)	$ 5,527,300
Interest	12,400,000
Upkeep	16,750,000
Total	$34,677,300

or nearly $862,000 a year as an average. The yearly charge

varies from $57,830 in the first year to $1,073,800 for the thirteenth year, at which maximum it remains to the thirtieth year, after which it decreases to the fortieth year, where it becomes $500,000, the repair charge.

If, on the other hand, a fund of $860,000 be set aside each year to keep roads built in repair and the balance used to build roads, the 1,000-mile system would be finished in less than seventeen years. The cost of the system with its maintenance to the end of the 40-year period would be $25,779,000. There is a saving of almost $9,000,000 against which the community has enjoyed the use of the whole system for about nine years more time.

The money spent will have been disbursed as follows:

For construction	$10,000,000
For upkeep (40-year period)	15,779,000
Total	$25,779,000

If the average yearly disbursement of $860,000 be kept up for the whole period of forty years, it would be possible to increase the total mileage to about 1,525, but from that date on the upkeep charge would be $763,000 instead of $500,000.

All of these plans, as well as one providing for a gradually increasing charge, deserve and should receive consideration before deciding on the method to be followed in any case.

The general consideration of how the roads, after being planned and built, are to be kept in order, is a vital part of administrative work. A thorough comparison of the total cost during a period under different financial plans involves such consideration. The changes of the last few years in the character of road traffic, its unforeseen increase in amount and in destructiveness to road surfaces emphasize the need for the most liberal allowances for this item. There are certain items in the cost of a road that are permanent investments. The right of way is pre-eminently of this class; the grading, drainage, and, in some cases, the foundation, are of such a nature that with reasonable care they can be kept, at a small yearly charge, in such condition that no depreciation takes place. The surface, however, is frequently of a material that cannot be made good every year. These, after a term of years, will have to be replaced and hence an item of damage that cannot be made good every year will introduce a depreciation charge to further complicate the problem.

The difficulties cannot be dodged or sidetracked. The very fact of the wonderful growth of road traffic in the last few years but emphasizes and proves beyond doubt the growth

in importance of the road and of its value to the public. However costly a good road may be in its building and upkeep, it is less costly to the community at large than a bad road. It is the duty of the road administrator to see that the road is provided and kept in a condition to return a profit to those who pay for it.

Our highways are a part of the vast transportation system of which our railroads form the hitherto most conspicuous link. It is in the development of the former that we must seek one of the factors in the increase in industrial and specially in agricultural efficiency, to the necessity of which the economist of today is calling attention. In the language of the street it bears on the "high cost of living." The problem is no trifling matter. The amounts to be spent on roads in these United States within the next forty years will far exceed the cost of the Panama Canal. The ever increasing debts of our municipal and county governments are a serious draft on the fund that the nation can provide for public works. The demand today may not be as loud elsewhere as in New Jersey, but it is only a question of a few years before we shall be thoroughly awakened and before public opinion will no more allow of inefficient roads than of poor schools. Such is today the case in Europe.

To meet this demand, under the conditions of public finance that now seem likely to prevail, is well worth the study and the most diligent effort of our best administrators. The American has always met such problems and overcome them somehow, not always in the most economical way, but he has gotten there. I have no fear that our roads will furnish the only exception to this rule. It is, however, up to us to see that no waste occurs. We need every cent available for roads and we must get the utmost out of each and every cent if our duty is to be fully discharged.

PRESIDENT HILL: Gentlemen, you show by your generous applause how much you appreciate the paper which has just been read. Before we proceed to its discussion, I presume those of you who were not with us last year have been wondering who this distinguished gentleman is on my left. He represents the great nation of France—a nation to which the world owes more for its progress in road building than to any other. He is Mr. Jean de Pulligny, Director of the French Mission of Engineers to the United States, and a recognized authority on road building, who honors us by his presence today. In a little while I am going to ask him

to say a few words to you; he will speak on the paper following this.

First on the program to take part in the discussion on Col. Stevens' paper is Mr. A. N. Johnson, State Highway Engineer of Illinois.

A. N. JOHNSON (State Highway Engineer of Illinois): Col. Stevens has very ably pointed out the essentials to proper organization for effective road work. Profiting by the experience of other states, the Illinois Legislature passed at its last session one of the most comprehensive road laws to be found in any state, embodying as it does many of the main features suggested in Col. Stevens' paper.

The new Illinois road law, known as the Tice law, provides not alone for a system of main roads but revises completely the road laws of the state. Whereas in most other states the state aid road laws have been added to already existing laws and these in turn changed from time to time, the Illinois law embraces all the road work of the state.

First, provision is made for a state highway department, having immediate control of the state aid roads. Instead of selecting these roads haphazard, as has too often been done, it is provided that each county board shall submit a map of the county, indicating thereon a certain fixed percentage of the total road mileage as the main road system for that county. The smaller counties select 15 per cent. of their road mileage and the larger counties 20 per cent, Cook County alone selecting 25 per cent.

These maps are submitted to the State Highway Commission and by it revised so as to harmonize the road system of one county with those of the neighboring counties.

Where the roads of one county do not connect with those of another, the State Highway Commission may make such changes as will effect these connections. These maps as finally approved by the State Highway Commission are filed with the various county authorities, as well as in the office of the State Highway Commission and may not be changed for a period of three years. All state aid roads must thereafter be built somewhere on this prearranged system, the total mileage of which is approximately 15,000 miles.

The cost of construction of state aid roads is divided, one-half coming from the state and one-half from the counties. The selection of the particular pieces of road on which the construction is to be undertaken is left to the county boards with the restriction that it must be somewhere on the pre-planned system. This selection, however,

is subject to the approval of the State Highway Commission, the intent of the law being to form a partnership between the state and the counties, placing the initiative and as much of the selection as to routes and type of roads with the local authorities as possible. At the same time, all such selections must be approved by the State Highway Commission, which thus has the authority to shape the work to conform to a system as a whole.

The construction of the roads, subsequent to the approval of the plans by the State Highway Commission and the county boards, is carried on entirely by the state, under the immediate direction of its own corps of engineers.

The most important feature of the law in connection with the state aid roads is the provision made for their maintenance, which devolves upon the State Highway Department. After a road has been constructed, with the aid of state funds, it is then to be maintained wholly at state expense.

The state funds may be raised from several sources as the Legislature from time to time may indicate, the state road fund at present being derived in part from automobile license fees and in part from direct tax.

There is thus established, it will be seen, a complete organization for a unified system of roads throughout the state, which will become the main traveled highways and carry eventually from 80 to 90 per cent. of all the traffic on the public roads.

In each county there is a county highway superintendent. This officer is selected from a group of five candidates named by the county boards. These candidates before they become eligible for appointment to office must pass an examination given by the State Highway Commission. These examinations have been given and candidates found eligible in a majority of the counties; but there still remain a few counties which have yet to name their candidates.

The duties of the county superintendent are divided, partly advisory and partly authoritative. For example, the law provides that he is the adviser of the local officials in all matters connected with road and bridge work; also that no contract for road or bridge work in the various townships may be entered into by the local highway officials without his approval.

The county superintendent gives approval to road and bridge plans in accordance with general rules and regulations that are prescribed by the State Highway Commission for his guidance. He also acts, when called upon, as a deputy to the State Highway Engineer.

The State Highway Department will issue from time to time suggestions to the various county superintendents for the general purpose of unifying and making more efficient the expenditure of the local road taxes in each township.

The law also provides that the State Highway Commission shall provide a form of auditing and accounting for each township or local road unit, of which there are about 1,600 in the state.

This brief outline gives a general idea of the system for road administration in Illinois. In general, it has left, as far as possible, the initiative and the decision as to the amount of tax to be raised and the work to be done to local authorities where this method will not be inconsistent with an efficient policy regarding the townships as parts of a whole.

The law leaves, very properly, much to cooperation between the state, county and township officials, rather than prescribing fixed and definite authority for each.

Several of the states have already passed road laws providing for county superintendents of highways, giving them great authority and leaving little or nothing at the option of the local officials and local communities, with the result that these laws have been far ahead of public opinion and have resulted only in antagonizing the local communities and the central authority. Whereas in those instances where the result of central authority is to be largely exercised through friendly cooperation, every advantage may be taken of favorable public opinion and at the same time keep within limits which do not antagonize such opinion. Thus there is an opportunity for the growth of a better and more enlightened public sentiment that will result in a greater appreciation of the efficiency that comes from increased central control.

It is not the theoretically perfectly adjusted system for the administration of public work that proves the most efficient in practice. Good road laws that do not permit of flexibility so that the officials in charge of the administration of the law can adjust their work to varying public opinion fail practically of their purpose.

It is this feature of flexibility in the Illinois road law which makes it, in the judgment of the writer, one of the best conceived state road laws to be found on the statute books. There is sufficient authority given to the central administrative bodies to start and to demonstrate the efficiency that should result from such central organization. At the same time, there is not removed from the local

authorities and communities that sense of responsibility which is essential for the effective cooperation necessary to the success of work of this character.

PRESIDENT HILL: I want to invite Mr. James H. MacDonald, our first President, to come to the platform, if he is in the room. I saw him here a few minutes ago.

The next speaker will be Mr. F. W. Buffum, State Highway Commissioner of Missouri. (No response.) He is not in the room at the moment. In that case we will call on Mr T. H. MacDonald, Highway Engineer of the Iowa State Highway Commission. (No response). Mr. MacDonald not being present, we will call on Mr. A. R. Hirst, State Highway Engineer of Wisconsin. Gentlemen, Mr. Hirst, of Wisconsin. (Applause.)

A. R. HIRST (State Highway Engineer of Wisconsin): This seems to be a case where many are called but few are chosen. (Laughter.) When I see the surprisingly large audience here, I feel some hesitancy about giving a talk without having prepared a paper, but the truth of the matter is I am on a vacation and refuse to prepare a paper.

I was very much surprised to hear my friend Johnson claim that Illinois had the best highway law in the United States, because we think we have. (Laughter.)

The Governor of Pennsylvania stated that Pennsylvania was a large state. It is, and a great state, but we have a state that is quite some state too—56,000 square miles, about 350 miles in one direction and 250 in the other.

Wisconsin is an agricultural state, and conditions, as the Governor very well stated, are vastly different in different states, and I really doubt, sometimes, whether there is very much to be gained by discussing what has been done in one state, because it is of very little benefit to other states.

Of course Wisconsin, when it started this highway work, had to do something a little different from any other state, just as we have always had to do. We think—or rather we don't think, we know—that we have a law that suits our conditions there, but I would not say it would suit the conditions in any other state. The ground work of what we have called the Wisconsin idea is that we start from the bottom and work up.

Outside of Massachusetts, possibly, we leave the initiation of road building in a smaller unit of government than any state. We have, in Wisconsin, 1,200 towns which are separate units of government for local purposes, and our law, in brief, provides that when any town votes a sum of money, the county has to duplicate that amount, and the

state, if the state funds are sufficient, also duplicates the amount and the road is built where the town says it is to be built. Now this is not an incoherent system. I think Illinois borrowed a little something from us. The law provided that the county must lay out the state system of highways not to comprise over 15 per cent. of the mileage, and those highways must connect at the county lines, so that our state system is a continuous system from one end of the state to the other, crisscrossing in every direction.

We have 65,000 miles of road in the state, of which 12,000 miles are on this so-called state system. We have operated for only two years; this is our second year of construction. The first year we had a state aid fund of $350,000. About 500 towns asked for $450,000 in state aid. The second year we had the sum of $378,000 and 900 towns asked for $830,000 in state aid. The Legislature met this last spring and made good the deficit in the state aid by an almost unanimous vote, appropriating $450,000, and gave us all that we asked for next year, $1,200,000 state aid, but the state aid applications for next year immediately jumped to $1,550,000, so the state aid is again deficient and we have facing us next year the construction of 1,700 different pieces of road and 300 bridges in 1,200 towns, villages and cities—which gives us quite a problem of organization. I do not think it could be handled in any other way than the way we handle it, which is a way at which any of the eastern highway departments would be aghast.

The State Highway Commission consists of five members, three appointed by the Governor, one every six years; two of them ex-officio; one the Dean of the Engineering College of the State University and one the State Geologist. So we have a commission of five, one appointive member changing every three years, non-paid and well out of the reach of political influence. The direct administration of the work is placed in the hands of a state highway engineer selected by this commission. We have divided our state into seven divisions. In each we place a division engineer and give him a Ford car; we think this increases his efficiency about 100 per cent.

Then we have in each county, a county highway commissioner, and this commissioner, except in three cases in the 71 counties, is not a civil engineer. I think if road engineers have made a mistake, it is in adopting the idea, that all of the road building knowledge is centered in the civil engineers of the United States. We are going outside of that idea; we believe that the practical man is the man we want

to get hold of, and if we can get a county highway commissioner who is a practical road builder, who knows how to manage men and teams, we will take him every time in preference to some man fresh from college. We can get the civil engineering, we can get the surveying—it is the cheapest thing we have to get—but the ability to handle men and teams, the ability to get work done and done cheaply, is the hardest thing we have to get, and we get it by picking up hard-headed lumbermen, old railroad builders, men that possibly have never seen even the outside of an engineering college, but who know how to direct men and do work. The reason that is so essential with us is that 90 per cent. of our work is day labor work, not contract work. The jobs are so small, $3,000 or even $1,000 in some cases—though we have some jobs of $40,000 and $50,000—the majority of the work is so small that no competent contractor would bid on it, and we have had to devise a system whereby we do our own work under the day labor system.

Last year we had working in the state 125 complete macadam outfits and about 150 grading crews under our own direction, and it is rather interesting to note the cost data we have secured for a comparison between the day labor work and the contract work in the same county. We do a good deal of grading work up in the northern part of Wisconsin, where we sometimes pass one house in five miles. They are not quite ready for 15-ft. concrete roads yet, so we build what they are ready for—a good dirt road. But we build it so that when the time comes to surface the road, the road will be ready for surfacing. We have not, as Illinois has tried to do, started out by wiping out the old system of highway administration, though we would sometimes like to do it. As I say, we have 1,200 towns, and in each town there are three members of the town board; that makes 3,600 road officials right there. Each town is divided into from 10 to 50 road districts, and in some of the communities, they have as many as 50, averaging about 20 pathmasters to the town—about 24,000 pathmasters. And the results of this system of expending about $3,500,000 outside of our work are so glaringly bad that we hope to have the people of the state come to us and ask us to take it, instead of taking it away from them before they are ready for it.

The pathmaster system works out just as it did in the East. It is illustrated by the story told of one of our road districts. We have a system whereby the farmers work out the tax, and if they don't work it out, it is returned and payable the next spring as a cash tax. We had one district

where the tax was $250. When it came time to report to the town board, the pathmaster reported, "Road tax in my district, $250; none worked out; none paid in cash; everybody satisfied." (Laughter.)

That is just about the way the old labor tax system has worked out at its worst. We believe that with these samples—these 900 samples of road that we built last year, the 1,200 samples we built this year and the 1,700 samples of fairly efficient (some of it mighty efficient) work we will build in 1914 in Wisconsin—the people of the state are going to come to us and say, "Take it all." And I think on the whole it is a little better to have legislation a little behind the sentiment in your state than a little ahead of it.

We propose to ask one other improvement in the law from the next Legislature, and that is, we want to pick out, just as the eastern states have picked out, a system of roads, the real, main traveled roads of the state, comprising possibly 3 per cent. We are not going to go in and improve them and give them to those localities, but we will provide that when a locality puts up its one-third, the county one-third and the state one-third, in addition to that state third, the state will give a 50 per cent. bonus, and I believe that we will get our state system of roads just as quickly as some of the eastern states, and have a much better distribution of the cost.

I think our law provides more ways in which we can get road improvement than any other law. We have, first, the vote by the town of one-third, the county one-third, and the state one-third. If the county is a rich county—and we have some rich counties in Wisconsin—the county can pay two-thirds and the state one-third. If they don't want to do that, and anybody, in any county, desires the improvement of a piece of road in that county, by putting up one-half of the town's share of the cost, or one-sixth of the whole cost of the road, they can secure the desired improvement, no matter if 100 per cent. of the people in the town in which that improvement lies don't want it, and under that so-called force clause of our law, whereby the subscribers put up a sixth, the town a sixth, the county a third and the state a third, we raised in Wisconsin this year over $150,000 in private subscription, meaning improvements aggregating over $900,000. And all of that improvement originated either with the people of the towns and the cities or the farmers in the country.

It is surprising, gentlemen—at least it has been a wonderful surprise to me; I was raised in the East, and got my first

highway experience in Maryland—I repeat, it has been a wonderful surprise to me that when you start from the bottom and show the farmers that they are getting value for their money, how much they will do, and I think the eastern states have neglected one of their strongest sources of revenue in passing over the farmers' heads and starting from the top down.

There can be no doubt that when a piece of road is built through a town or a district, the people of that town or district are more interested than others in their road and should pay a larger share of its cost than someone who lives fifty miles away. And there is no reason why the man in front of whose farm this road passes, should not pay an additional amount over the man whose farm it does not pass. We are going to provide, if we can fix any possible way, for the creation of road improvement districts, so that those who are directly benefited by the construction of any road can pay for the benefit which they receive.

I want to say a word about bond issues—Col. Stevens touched on that point. I thank Heaven that the constitution of the state of Wisconsin says we cannot bond. It is one of the best things that ever happened to the state; we are getting more growth without bonding than we can possibly attend to now. We have town and county bond features in our law, but the bonds can only run for ten years, and that is just about all that any highway bond ought to run until we know more about building roads than we know now. They run ten years, and they must be retired, one-tenth this year, one-tenth next year, and so on until, at the end of the ten years, they are all retired. But even at that, with 4½ per cent. ten-year bonds for $1,000,000, it costs the community that issues those bonds, $1,247,500 for $1,000,000 worth of road. We believe it is better to pay as you go. We have a few counties that have bonded and there are a few towns that have bonded, but, in general, rather than a bond issue producing economy, I believe that exactly the reverse has been true. There has been so much money thrown at the heads of the state highway departments and so much money thrown at the heads of the county highway officials that they could not see the end of it and spent it recklessly. On the other hand, when you know that you have to go to the people next spring and pull the taxes for these improvements directly out of their pockets, you will be mighty careful how you spend that money, because they are coming right back at you. I think one of the proudest things we have to boast of in Wisconsin is that next spring there will

be imposed a direct state highway tax of $1,650,000; I believe the largest direct highway tax ever imposed in the United States, and the people of Wisconsin are going to stand for it, and if we cannot justify this expenditure so that the people of our state will stand for it, we want them to repeal the state highway law because it is a failure. A state highway commission that continues to exist only because the taxation is indirect and the people don't know they are being taxed, has very little reason for its continued existence. I thank you for your attention. (Applause.)

PRESIDENT HILL: Gentlemen, the next speaker on the list is Mr. Sidney Suggs, State Highway Commissioner of Oklahoma. Is Mr. Suggs in the room? (No response.) He doesn't seem to be present. Is there any one desiring to speak further on this subject? If so, the chair will allow a few speeches of five minutes each. If not, the next subject will be taken up. The next subject is number 2, "Division of Expense, Responsibility and Authority Between Nation, State, County and Town." The first speaker will be Mr. S. Percy Hooker, State Superintendent of Highways of New Hampshire. (Applause.)

DIVISION OF EXPENSE, RESPONSIBILITY AND AUTHORITY BETWEEN NATION, STATE, COUNTY AND TOWN

By S. PERCY HOOKER

State Superintendent of Highways of New Hampshire

I think the question of policy as to whether the nation shall share in the expense of the building of highways is already settled and needs no discussion. We may expect within the next four years at any rate national aid. I take up the questions as given me, therefore, without arguing as to whether rightfully the federal government should participate in such building. Three broad plans present themselves as to federal aid.

1. Shall the federal government adopt certain highways regardless of state lines and proceed to improve and maintain such highways irrespective of the states in which they lie?

2. Shall the federal government apportion certain sums of money for the care and maintenance of post roads and contribute to the town in which individual roads lie, either a proportion of the cost of maintenance or a fixed sum per mile?

3. Shall the federal government apportion a sum of money to be divided among the different sub-divisions of the states

for construction of improved highways regardless of their future maintenance?

To each of these questions I unqualifiedly answer, "No," and while it is always easier to be destructive than constructive, I shall first give my reasonings for negativing all these propositions and then endeavor to sketch a plan by which I think an expenditure of money by the federal government can be safeguarded and the best results obtained.

So far as I can see the arguments advanced for any one of the three plans suggested have been based upon the personal, selfish ideas of the proponent as to what methods will be best for him.

The motor tourist realizes that through roads would be of an advantage to him and in almost every instance is an active adherent of the first plan—to have the government build and maintain through roads.

A farmer feels that any direct contribution from the national government would relieve him of so much direct tax in his own town and he is for plan three.

A congressman looking at the pork barrel, which this appropriation would become were plan two adopted, feels that by log rolling he could procure a larger share of the money within his district than in any other way, and most of them say gleefully, "the pork for us."

It seems to me that the real solution of the question cannot be arrived at by any such methods. We have had state aid of various types in many of the states over a series of years and I think the plan for national aid should be evolved from the experience which has been gained from the operation of state aid.

First, I will take up the objections to plan one. If the federal government builds and maintains certain through highways within a state there must be created a department of the federal government which in its magnitude would dwarf many of the other departments of government. I think also it would tend to the standardization of roads, which I believe would be a menace rather than an advantage.

There is such a diversity of soils and of traffic that I think standardization of highways would be the most unfortunate proposition that could be attempted.

It would be the height of foolishness to build in sections of Arizona and Kansas a standard highway which would be applicable to Westchester County, N. Y., and Suffolk, Mass., or Chester, Pa., and anything that would tend to this result would be a fatal blow at the principle of federal aid.

This is easily answered by saying that the federal

department would not commit this blunder, but I believe that under state aid more millions have been wasted in building too expensive roads than has been wasted by faulty construction or any other error.

I have read many of the different estimates of expenditure for the building of the transcontinental and through highways which some organizations are asking that the federal government accept as national highways. I do not recall that I have seen an estimate which exceeded $250,000,000, but it is clear to my mind that this is nothing but an entering wedge and that the cost, if this plan is followed, will run into the billions. Such highways, further, cannot be equitably apportioned on any base or ratio among the states.

Suppose the transcontinental route selected should run across Minnesota, Dakota, Montana, Idaho and Oregon, does any one for an instant believe that the route through Missouri, Kansas, Colorado, Utah, Nevada and California could be cut out and omitted from the plan of through highways? Will not the southern route, Arkansas, Oklahoma, Texas and New Mexico, be equally as insistent and will it not be equally as important? If you build a concrete highway on the middle route will you not have a duplicate on the other two? I can see no other solution than the expenditure of sums which are to me too vast to contemplate.

As to maintenance, if the entire United States Army were put out to maintain and patrol the roads on your final system there wouldn't be enough men left to guard the coast defenses. The head of such a department would know personally nothing of the work done by his subordinates.

Were he changed in office once in every four years he never could have seen a vast majority of the roads built under his direction. As well expect the general in the army to personally know each private, as your superintendent of highways to know anything about each of his subordinates.

I have nothing more to say in favor of plans two and three than of plan one. I believe that the money sent in to the town treasurer in a town on a rural delivery route would be used in the same manner that the town money now is upon that road.

I do not believe that on the whole you would have present conditions very much improved and while the cost to the government would be whatever Congress cared to make it, the improvement of the roads would be practically negligible. I appreciate that, so far, I am only knocking and have not in any way touched the point as to what should be done. I

therefore plan a little schedule which I think would be a reasonable and comparative method as to federal aid.

First. Organize a department of highways under the federal government.

Second. Insist upon the organization of a state department of highways in each state as a condition precedent to receiving any state aid.

Third. Cause road maps to be furnished by each state department of all the roads within the state, showing comparative assessed valuation per mile of the state as a whole as a basis for federal aid. This map should show the highways which in the estimation of the state department, might be classified or numbered as to their value as through routes, considering traffic and location.

Fourth. Compute the proportionate per cent. which the federal government should contribute by using the three factors, population, mileage and assessed valuation, giving the states different ratios based upon this statement.

Fifth. Have the state department certify to the federal department the amount which it would have available for construction and maintenance in any given year and base the federal aid upon the amount raised apportioned from the ratio previously found.

Sixth. Have the state department file with the federal department an application for federal aid upon given pieces of highway indicating them upon the maps, so that the federal department would know exactly where such federal aid was to be placed; such location to be on either a continuous highway to be built under federal aid or connecting highways already built under state aid forming such continuous highway.

Seventh. Have the state department file its plan indicating the class or type of road which it desired to build.

Eighth. Have the federal department pass upon the general plans of the state department upon the various types of road.

Ninth. Require the consent of the federal department to the type indicated as being used.

Tenth. Have the entire work of construction and inspection in charge of the state highway department.

Eleventh. When the work was finished have it inspected by the federal department and accepted or refused as it complied with the specifications for the class selected.

Twelfth. Have the state highway departments certify as to the actual cost of such improvement with such detail as the federal government might insist upon and then have the

latter remit such proportion of the cost as had been apportioned before the work was begun.

Thirteenth. Have the money given by the federal government for maintenance only, expended upon such highways as had been built under federal aid, and in the same proportion as the ratio of cost.

Fourteenth. Give to the federal department the right to withhold all aid both for construction and maintenance if the highways built with its aid were not properly maintained.

I realize that this is simply the plan of state aid as adopted by many of the states except that the supervision is taken from the federal government and placed with the state highway department.

The reasons for this are that the state department would be far more likely to be conversant with the needs, wishes and desires of the travelers than the federal department, and with the clause that such federal aid should be only expended on continuous highways, it seems to me that a system would be completed far more rapidly than if the federal government were to assume the entire charge of such highway.

It seems to me that by such plan the state departments would be able to select the class of construction which was best adapted to their state, and that if Colorado or New Mexico was satisfied with a graded highway, while New York and Massachusetts required a pavement, the best interest of all would be conserved by permitting the building of the class of road which the state officials thought was sufficient.

The federal government having made a general specification as to how a pavement should be laid, calling this type, for instance, class "A," with other specifications for, possibly, bituminous construction, called class "B," or plain macadam as class "C," for gravel as class "D," and for grading as class "E," should be satisfied to award federal aid, provided these specifications were in general carried out and there be no reason for withholding federal aid because of a difference of opinion as to how much per mile should be expended.

You could rely upon the protests of the people residing in the state if satisfactory results were not obtained by the state department, and I do not see that the interest of the federal government would be injured.

I realize that I am using the unit of dollars, rather than of miles, and I intended to do so.

For an illustration, suppose that the federal aid for the state of Nebraska be apportioned as 60 cents upon each dol-

lar expended by the state upon these continuous highways and that state should raise for such highways the sum of one million dollars, receiving the six hundred thousand dollars from the federal government and the state department should prefer to build eight hundred miles of graded highway, including proper drainage and complying with the specifications of the federal government. I believe that the contribution from the latter would accomplish most satisfactory results to the state, while should the federal government insist upon expending the amount of one million six hundred thousand dollars upon eighty miles of pavement, it would bring the whole scheme into disrepute immediately.

If Massachusetts was entitled to twenty-five cents upon the dollar and raised the same amount it would be equally foolish for the federal government to insist upon the expenditure of this million and one-quarter upon any of the intermediate plans of roads, say class "D," when the Massachusetts department desired class "A."

This plan would allow the state department to determine whether the improvement was to consist of an extensive mileage at low cost or a low mileage at an expensive cost.

The states which have done little road work and which have a large mileage would naturally wish to improve as long a stretch of road as possible, while the states where more money had been spent upon construction would naturally turn to the expensive.

There is one portion of the problem where I imagine that I am at variance with most people who have thought out the subject. That is the divisions as between construction and maintenance. My first thought was that these should be divided, but that the sum which the federal government made available for each state should be used where needed either in maintenance or construction. I have finally decided, however, that such a course would result in many instances in not extending the construction of new highways and that the money in many instances would be expended almost entirely upon the maintenance of highways already built.

In my plan, therefore, I limit the maintenance given by federal aid to stretches of highway which have been constructed under federal aidd I assume that the main purpose of such aid is to procure more stretches of improved road and that very few people would be satisfied with the expenditure of the entire federal fund upon the keeping up of roads under some other system.

I realize that in some states where the through highways have been practically completed a different course might

be employed, and that the keeping of all these highways is more essential than the building of new ones. While I have no definite plan as to how this might be accomplished, it occurs to me that a state department (its main highways in which the government was particularly interested having been completed) might procure from the national department an acceptance of the highways already built, as such through highways, thereby making available the federal aid for their maintenance as federal aid highways.

My attention was called to a statement by a prominent official of one of the automobile associations, in which he declared that the roads constructed under the federal aid would be of such a nature as to require the entire rebuilding of federal highways. That such highways should be not less than forty feet in width and possibly made into boulevards, where the traffic was required to take one side of the road in one direction and the other in the reverse. I think that this course would be fatal to the cause. Imagine such a highway in New Mexico and the cost of maintenance as distinct from the cost of actual wear.

I presume this is a modified plan in use in France where the roads are classified and then maintained either by the national government or by the different divisions of the republic.

The United States having an area of fifteen times that of France and the distribution of population being very different, as is shown by the population per mile in Rhode Island, 256 per square mile, while in Kansas there are only 17 per square mile, I do not think it will be wise or possible to attempt to carry out a plan of making the national highways a distinct factor or feature.

As a matter of fact, on the French plan the national highways would nine-tenths of them be built in the section north of the Ohio and east of the Mississippi River, as, of course, the principal traveled roads are in these sections.

I find that I have said nothing of the relations of the minor sub-divisions of a state to the general question. I think this portion of the question has been settled by the various state aid laws.

In general, of course, the most important roads will be taken care of under federal and state aid increased by varying amounts of the town's contributions. The minor roads will be left in charge of the town authorities. Sooner or later this class of road will doubtless receive state aid and the building and maintenance will be under, at least, the supervision of the state authorities, but if I read the in-

tent of the subject assigned me correctly, it is principally directed to the question as to how federal aid should be distributed.

In considering this question the most important point is to arrive at an understanding in which the state and federal departments do not and cannot clash.

The greatest argument that I can think of for the proponent of the plan of the federal government selecting certain continuous highways and building them, leaving the state departments only the control to manage the minor highways, is that there would then be absolutely no conflict.

In all state aid laws we have assumed that the state department is far better advised than the town department and have given direct supervision to the state department. I do not think this should apply in taking the next step because of the fact that the state department does not and must not have the same basis of knowledge and engineering that the federal government would have.

In a town the shifting officials change from year to year, and at any time there may be placed in power people who have actually no knowledge of building highways. Their work upon them might be a detriment rather than an improvement. This could not apply to state departments, which must of necessity be in the control of men who have studied road situations and are competent to judge.

I assume that as a class the men at the head of the state department would be fully as well informed and of a higher rank than the subordinate of the federal government who would be in charge of that sub-division.

If you do not concede this, then the latter must receive a larger salary and you have added to your overhead charges by putting two large salaried men in charge of the same work. I do not feel that I have made this statement as clear as I should, though it seems, to me, most important.

Perhaps the most difficult matter of adjustment according to this plan would be the proportionate amounts which the different states should receive. There can be no question that the state with a larger proportion of roads to its means should receive a larger amount of federal aid than the richer state and the first idea is that naturally the assessed valuation per mile should be the unit in determining a proportionate aid, but it seems to me that there is another element, that of population, which should be included because of the fact that the population makes the use of the road, and there should be some attention given to the proper distribution of the money on the basis of such population.

One of the abuses which has crept into the state aid laws of the different states is the fact that villages are constantly asking for state aid upon their village streets. It seems to me that it should be clearly outlined that federal aid should be only upon country roads, and I should be very glad if the different state aid laws were amended so that state aid, even, must be upon the same basis.

In many of the states the laws have been amended so that a considerable portion of the state aid is now spent within villages, and this I consider to be at any rate unwise. I realize that on a through highway frequently the outlets to such highways in the cities even, are in far worse condition than the country roads, but it does not seem to me that even state aid money should be spent upon improving the streets within a municipality and especially as such streets, if really receiving state aid, require, naturally, a higher type of road than outside the municipality limits, which, as a corollary, means more money per mile expended within such municipalities.

PRESIDENT HILL: Mr. Nelson P. Lewis, Chief Engineer of the Board of Estimate and Apportionment of New York City, will open the discussion. (Applause.)

NELSON P. LEWIS (Chief Engineer, Board of Estimate and Apportionment, New York, N. Y.): Ladies and Gentlemen: I am very glad indeed that Mr. Hooker has had the courage to accept an invitation to prepare a paper upon this subject. There may be a suspicion that, at meetings of this association, there has been a disposition for some time to dodge this subject and I think that it should not be dodged any longer. He seems to fear, however, that his attitude is too conservative to suit most of you. Well if that be true, I don't know what you would do with me. (Laughter.)

He is perfectly right in saying, however, that "federal aid" in one form or another is coming; there is no question about that. When it does come we hope it will come in a sane fashion. Mr. Hooker has presented to you three distinct plans or questions as to how federal aid shall be given, and he has answered them all with an emphatic negative. In this, I entirely concur; that is, in any of the plans that involve the doling out of cash from the federal government to the states or sub-divisions of states to be used by them as they see fit, or the invasion of the local field by the federal government to build, with its forces and under its own supervision, a great system of national highways without regard

to state boundaries or local jurisdictions. As to the results of this largess from our Uncle Samuel, I want to take a moment of your time to remind you of some things that have occurred in the past century of our history—this is not going to cover a century; it is not going to be long.

It was in May, 1822, that President Monroe vetoed a bill passed by Congress providing a very small amount for the erection of toll gates on the Cumberland Road and carrying an appropriation of about $8,000. That veto was given, however, strictly on constitutional grounds. Two years later, in January, Mr. Van Buren, then in the Senate, proposed an amendment to the federal constitution which would permit Congress to appropriate moneys to be used for internal improvements, and the veto of President Monroe and this proposed amendment of Mr. Van Buren brought to the front this question of internal improvements to be paid for by the United States government in rather an acute form, and the debate raged for some years. This attitude of Mr. Van Buren and others was doubtless due to an extreme jealousy of the states' rights which they did not want infringed by the entry of the federal government or giving it jurisdiction over any internal improvements whatever.

A little later, in February, 1825, Congress passed a bill carrying an appropriation of $150,000 to extend this same Cumberland Road and also another appropriation to construct the Delaware and Chesapeake Canal and the Dismal Swamp Canal. This precipitated another controversy which raged through the session and was again renewed three years later, in 1828. A little later, the second President Adams, in his inaugural address, came out as an avowed advocate of internal improvements at federal expense, and you will find this sentence in his inaugural: "The magnificence and splendor of the public works, roads and aqueducts of Rome were among the imperishable monuments of the ancient republic." We don't often see a passage of that kind in a presidential message in these days. We do hear those rounded periods and that kind of eloquence in public meetings and from the platform and they are usually greeted with vociferous applause, which was somewhat like that the Roman populace gave utterance to in its cries for "Bread and the Circus."

In 1830, President Jackson vetoed a bill providing for the improvement of the Maysville Road, lying wholly within the state of Ohio, and not connected with any other existing highway. Again all through the year 1830, both

presidential messages and Congressional debates were full of the question of internal improvements. It was argued, among other things that if the Erie Canal, opened in 1825, and paid for by the state of New York, not by the federal government, had been so beneficent in its results, that the same thing should be done in other states.

The idea of apportioning money, by the federal government among the states reached its climax in 1836. Congress in that year passed a bill providing that all the money in the United States Treasury above the sum of $5,000,000, on January 1st following, should be deposited with the various states in accordance with their population. According to this law, this was to be but a loan, but Henry Clay declared that not a single member of either house believed, for a moment, that one dollar would ever be recalled. He maintained that it was a mere gift. The first quarterly installment, which was due on January 1, 1837, amounted to $9,367,000. It was distributed among the states. There was a great financial disturbance immediately following this withdrawal of the funds from certain state deposit banks and grave doubt was expressed as to what would happen when the second quarterly installment was paid. It was paid on April 1; speculation had been rife; it had been stimulated by this prospect of federal largess to the states, and within eight days after April 1st, there were nearly one hundred failures in New York City alone, and 28 more within the next three days. There were no more quarterly distributions. Mr. Van Buren was then President and if there ever was a man who was a victim of unfortunate circumstances, it was he. When he saw the consequences of this amazing folly, he stood like a rock against the importunities of his party and went down to defeat because he would not sanction this distribution of federal funds among states.

Now as to the details of Mr. Hooker's paper, which I had the opportunity of reading before I came here, there are one or two things that are a little startling at first. For instance, he deplores the federal construction of highways because it would result in an attempt to standardize highway construction which he would regard as a misfortune. I admire his courage in saying this, for in these days, when we hear so much about standardization and efficiency methods, it is refreshing to hear a man raise a protest against an attempt to standardize for us a practice which must vary so greatly in every state, in every county, in every town. With the local materials at hand, the wise use of such available

local materials is the secret, in my judgment, of economic and efficient road improvement. (Applause.)

He points out also that the maintenance and patrol of such a system would be a stupendous job and would take an army. You may say, "But why can't we administer a great highway system as efficiently as the federal government administers its postal system and its customs service?" The cases are very different. The postal system and the customs service are routine work and are operated along the same general lines in all parts of the country. It is not so, however, in the building of our highways, and it would be folly to attempt standardization in the building of national highways and organize a great force working under the same rules and regulations in places where the conditions are widely different.

Now, as to the plan proposed by Mr. Hooker, I don't know that there is any use in my attempting to review it. I am generally in accord with the plan which Mr. Hooker suggests, although it will need a good deal of thinking out and careful working out of details, some of which are not covered.

For instance, I do not quite see how he gets at the percentage of the state appropriation which the federal government will meet. I assume that his three factors, population, assessed value and mileage, will be combined; that the state which has a great mileage and a sparse population or a low value, would receive from the federal government a greater percentage of the amount which the state itself is willing to provide; in other words, that the amount to be contributed would be in inverse proportion to the ability of the state or the community to pay. He says that when the state applies for aid, it should indicate the kind of road which it wishes to build, and that it should be the sole judge; and he divides the roads into five classes: a graded road, a gravel road, an ordinary macadam road, a bituminous macadam road and a pavement. I don't think I could go quite so far as he does in saying that if a state wished to build a great mileage of graded roads, without surface treatment, the federal government should pay its percentage of the amount raised, which would be a larger percentage, mind you, in such a state, than it would be in a state which could afford more substantial roads. I think the state must at least show its good faith and serious intentions by undertaking to build something quite substantial before the federal government should attempt to make any large contribution.

The question of maintenance is a very serious one. What

is maintenance after all? I could not, for a moment, indorse the idea that the federal government should furnish any portion of the cost of the ordinary everyday repairs, which would be so scattered that they could not be kept under very efficient control, and I fear that federal money would be used most unwisely and most lavishly if applied to any such kind of work. I believe, however, that maintenance includes periodic surface renewals, and when there is a surface renewal the federal government which paid for the original construction of that road, could perhaps, with propriety, be asked to pay the same proportion of that renewal, but to be asked to contribute towards funds spent in ordinary, everyday repair and patrol, I think would be very wrong—would result in much abuse. Again, if the roads were not properly cared for and maintained, the aid should be withdrawn at once. This is the system which today prevails in Switzerland. The Swiss Republic furnishes a considerable proportion of the cost of building and maintaining the roads in the various cantons. The work, however, is done by and it is entirely under the control of the canton, but if one of those cantons does not properly maintain its highways, contributions from the central government cease at once.

The question that bothers me more than anything else is this: Is it wise for the federal government to make an absolute gift of any funds? Now, I know you will say that if that is not done, the whole theory of federal aid is gone, but I must say that I was much impressed with the suggestion made by Senator Bourne a year or more ago. In some respects it was similar to that of Mr. Hooker. He took, I think, four functions, area, mileage, assessed values and population; the sum of those four gave the index number for each particular state; he assumed that a certain sum, $500,000,000 perhaps, was to be apportioned and each state would be entitled, if it wished it, to that proportion of that sum which its total of those four items bore to the grand total. The federal government would issue its bonds and turn that money over to the states, taking state bonds in return. The federal bonds would carry 3 per cent. or 3½ per cent. interest, while the state bonds would carry 1 or 2 per cent. more, depending upon the time the bonds were to run. If the state bonds paid 1 per cent. more than the federal bonds, the latter would be cared for, both principal and interest, in about 50 years; if 2 per cent. more, they would be cared for in 25 years; and the state bonds would then be cancelled. The difference between

the interest on the federal bonds and that on the state bonds would depend upon the character of the improvement. It is obviously absurd to liquidate, in the same time, the cost of permanent construction, which would last 50 years or more, of a paved roadway which would last for 25 years, and of a roadway with a rather superficial surface which would not last more than ten years; so that the extra premium which the state would pay should depend upon the character of the road to be built. That extra premium will amortize the federal bonds at their maturity, and the state bonds, issued only as security, would be redeemed and cancelled. You will say that is not state aid. It is, however, a very substantial assistance, loaning the federal credit to the states that are not permitted to bond themselves.

I envy Wisconsin, and I congratulate Wisconsin on the fact that, without the right to issue bonds for road purposes, she has gone on with her road improvements on a cash basis. Whatever may be the solution of this question, I, for one, sincerely trust it will not result in the appropriation by the general government of great sums of money to be used by the states as they see fit. The results of such a policy would be demoralizing and disastrous. I have called your attention to its effect 60 or 70 years ago, and while this country is bigger and greater and less liable to be disturbed by things of that kind than it was then, still the plan is essentially unsound, so unsound that I cannot believe it would meet with the general approval of the thoughtful people of the United States. (Applause.)

PRESIDENT HILL: Gentlemen, we will next listen to Mr. Harold Parker, formerly Chairman of the Massachusetts State Highway Commission. (Applause.)

HAROLD PARKER (former Chairman of the Massachusetts State Highway Commission): Mr. President and Gentlemen: You have had address you this afternoon two gentlemen who represented the State of New York at one time or another, and it shows you what New York can produce—Mr. S. Percy Hooker, who for several years was chairman of its Highway Commission, and Mr. Nelson P. Lewis, who, for more years than he probably likes to remember, has been one of the chief officers of the City of New York. These two gentlemen have given you two very distinct ideas of their own points of view, and neither has said anything different from what I should have expected him to say. Mr. Hooker has taken this proposition, which is of vital importance, and given it careful thought and produced a solution, or a partial solution, which he offers for discussion, and Mr.

Lewis has brought out many of the fundamental objections to that plan.

My own views are that any federal legislation at this time would be bad and wrong, and for this reason: I do not believe that any two men agree as to what form federal legislation should take. I think, Mr. President, that there are over two hundred and fifty bills in the Congress of the United States asking for assistance to the various states in the building of their roads. Each one is different, and, as Mr. Hooker says, most of them are based upon the pork barrel idea. I do not believe that it is possible for any two men, as I said, to agree upon what measures the United States government should take. Therefore, it seems to me—and I think it is the most important measure that there is before us for consideration at the present time—that the President of the United States should select five men or three men whose business it would be and to whom the means should be given to find out, by hearings and travel in this country and abroad, what should be the steps that this government should take, if any, to bring the federal money into the use of the different states. They should not be members of Congress—they should be an engineer, a business man, and perhaps a lawyer, or at any rate, they ought to represent all of the features of public thought. They should have ample compensation and ample means to solve—by the use of the best trained men that they could get—this question absolutely upon its merits. They should take three or four years to do it and should make a report to the President and Congress of the United States. In voting then upon this vital measure, the Congress would have something definite on which to work, not the scattered ideas of a thousand different people. They would have something which had been worked out from the foundation up and which they could rely upon as authentic.

Now, gentlemen, I don't intend to take up much of your time, because I believe that it is talking in vain for us to lay out any scheme for federal aid at this time. We need the careful research of people who are competent to give us advice, and not the selfish interests of any member of Congress or any body of constituents of a member of Congress. Now gentlemen, there is a committee of Congress already appointed that is supposed to make a report to Congress of what it has found out. That, gentlemen, is the way the matter stands at the present moment.

I think that in any expression of our views as a result of this congress we should concentrate our efforts and pre-

sent a resolution expressive of our feeling at this time that this matter should be referred to a commission such as I have outlined here.

Mr. President, Mr. Lewis referred to a sum of money, $9,000,000 I believe, which was returned pro rata to the states—a surplus that was distributed during Van Buren's time. I want to say to Mr. Lewis that a remnant of that thing is still in existence in the state of Massachusetts. There is a little town down on Cape Cod called Provincetown. It is nearly at the end of Cape Cod, and one of its peculiarities is that if you go to sleep there, the sun always rises in the west because the Cape follows around in a circle, and even if you have had no stimulants of any sort, you will be absolutely sure that the sun rises in the west. (Laughter.) In that little town there were several thousand dollars of this $9,000,000 that Mr. Lewis referred to which were to be spent on the roads and sidewalks of the town. They put it before a town meeting and opinion was almost equally divided as to what should be done with the money. It was carried, I think by three votes, that it should be spent on board sidewalks through the little streets of that town. The streets are so narrow there that the board sidewalks take up practically the whole space between the houses, but to this day, gentlemen, when those who opposed that measure and their descendants, come to these sidewalks they jump over the sidewalk and walk in the middle of the road, so as not to walk on them. (Laughter.) Now that is actually a fact, (Laughter) and it shows you what the persistency of these Yankees is.

But they have done this, gentlemen, which I would like you to all realize. In Massachusetts we have built our roads without federal aid. The same is true in Connecticut in a large measure, and also in New Jersey. In New York, if they did not continually fight among themselves, they would have done the same thing. (Laughter.) At any rate, there is enough money in the state of New York, now in the coffers or obtainable, to do all they need in New York without the assistance of the federal government. Now, I should like to ask Mr. Hooker how he would arrange it so that those of us who have provided money for building our own roads are to get a remission of our taxes for the building of other roads in other states. That is only one of the reasons that occur to my mind, why we don't want to go in and vote, or put this up to Congress to vote, while we are absolutely uninformed as to what should be done.

Now I have read Mr. Hooker's paper with great care and

I have made so many notes on it that it is difficult for me to decipher the original draft, showing you that I have given it very careful thought. (Laughter.) But I refrain from making any comments here to you, not only on account of my personal feelings of regard and admiration for Mr. Hooker, but because I don't think it would do any good. What I want, Mr. President, is the passing of a resolution somewhat to the effect of what I have said. Don't let these fellows go off when they are at half-cock. Consider the thing well before you do it. Now, gentlemen, I don't think I will take up any more of your time. I would like to say, in my own behalf, that it takes me just three quarters of an hour to get warmed up and I have not yet reached that point, so you will lose a good deal which you might otherwise have had. I thank you. (Applause and laughter.)

PRESIDENT HILL: Gentlemen, this discussion will be closed by our very distinguished guest, who is present, and although we may differ among ourselves, I think there is no man interested in or familiar with road building who does not recognize the fact of the great debt we owe to France, and I am sure that I, for one—and I think I voice your sentiments also—feel under great obligation today to Mr. de Pulligny, who comes here in a spirit of friendship, to try and tell us something about this subject. Gentlemen, I have great pleasure in introducing Mr. Jean de Pulligny.

JEAN DE PULLIGNY (Director of the French Mission of Engineers to the United States): Gentlemen, the hour being extremely advanced, I will be very brief.

You must not think that I come here to advocate the national ownership of roads, and I should even like to take out of your minds the idea that the national roads, the central government roads, are a very important part of the French system. They are an important historical part, because when they were built, there were no other roads in France and perhaps no other roads in Europe; but that was more than a hundred years ago. And now do you know what is the situation? Well, it is quite the reverse. The French national roads are but a very small part of the French system, not 6 per cent., and if you add the departmental roads which have been built directly and are owned by our little states—our 86 little states, our departments—you get only 9 per cent. of the total French system, so that over 90 per cent. of the French roads belong to the country townships.

And you must not think that the country roads are simply graded roads, they are all roads with metaled surfaces, and if you take the general account of the money which has

been spent on the French roads, you will find that 80 per cent. of the money has been spent on those country roads alone. I think that the question may be interesting to you because those country roads are precisely the roads which you have, which you build and which you need.

Well, those country roads, being 90 per cent. of our French roads, measure about three hundred and a half thousand miles. They have been built at the expense of the country townships with the help of our little states (departments) and with the help of our central government. I say that they have been built at the expense of the country township; I do not say they have been built by their care, because the building and the maintenance of those country township roads is intrusted to a force which is in the hands of our little states, the departments. The country township interferes only to appropriate the money.

I cannot go into the details and explain to you how it is obliged to appropriate a part of the money but not all. The little township council, the little local country parliament, keeps its liberty to a certain extent. I will only point out to you this, on the line of what Mr. Lewis said a minute ago, that not a cent of help is given for maintenance. The maintenance is all provided by the township, that is by the people who live along the road. As the gentleman from Wisconsin said, those people are the most interested and before they can get help for building a new road, the township must certify to the states, the little states, the departments, and to the big state, the federal state, that they have appropriated all the money which they have the right and which they have the obligation to appropriate for maintaining their roads.

It is too late for me to say anything of the remarkable paper of Mr. Hooker. I got it in advance, by the kind care of the gentlemen of the committee, and I read it with a great deal of interest. All I would say is this: The great problem before you is a problem of organization. I have already attended three of your road congresses (this is the third), and it seems to me that I see a real progress from one congress to the other in that the idea of organization is spreading among you and becoming foremost in importance.

It is the only thing you need, gentlemen, for this beautiful country. You have got the men, you have got the money, you have got the engineers, you have got everything; all you lack is organization. Your organization, as Mr. Hooker says, must begin by a proper state organization. Let not the federal government build any roads nor maintain them,

but let the federal government aid you and let that federal aid be handled not by lawyers or other prominent citizens who have the confidence of the democracy, but principally by technical men. (Applause.) It is for this handling that a federal force of engineers is needed. You need the state organization first, and I hope that the day may come when, as the departments do in France, the states will be able to handle the building and maintenance of the roads at the expense and with the concurrence and the moral help and support of most of the townships.

Now I will tell you that that state help and that national help has worked in my country for over sixty years. It works smoothly in accordance with the fundamental law which was adopted in 1836—that was before Napoleon III—and in accordance with important by-laws which have been passed from time to time. The last two of these have been in effect for the last roads built (as the network is rather complete in France now). Those two by-laws provide all the details for the distribution of state and federal aid, details which are very important. Before the department help is decided, there must be a good mapping, there must be a good designing of the portion of road to be built; there must be regular hearings of all the people interested, that they may give their advice or complain if they believe that they are unjustly treated; and others are allowed to answer, etc. All these details of organization are standardized and regulated in France by two by-laws which I have here, and those by-laws also provide a schedule of ratios for distribution of help between the townships by the departments, and for distribution of help to the departments by the central government. The schedule of those ratios is computed according to the assessed valuation per square mile, and that unit is a fairly good one. These by-laws I will hand to Mr. Samuel Hill, your eminent president, and I hope they may be translated or at least summarized in your proceedings and I shall be very happy if, by doing so, I have been of any help to my American friends. (Applause.)

PRESIDENT HILL: Now, gentlemen, I am requested to make the announcement that, if this convention so desires and will pass a resolution to that effect, the exhibits will be kept open this evening. What is your pleasure in the matter? Do you care to come here tonight to see the exhibits? The Chair waits for a motion.

[A motion was made, seconded and passed that the exhibits be kept open.]

Now, gentlemen, the meeting is open for discussions of five minutes each on this paper, to any of those who desire to discuss the question. I see Mr. McLean, from Canada. We cannot call on him, I presume, on the question of federal aid in the United States, but we would like to hear something from him about federal aid in the Dominion of Canada. Gentlemen, Mr. McLean. (Applause.)

W. A. McLEAN (Chief Engineer and Commissioner, Ontario Public Roads and Highways Commission): I am extremely happy to follow my friend, M. de Pulligny, who has been so good as to discuss with you this afternoon the question of federal aid. M. de Pulligny knows whereof he speaks, and I just wish to say this, that anyone who cares to study a splendid system of roads, the finest system of roads in the world, should study the French roads, for I believe that they are unequalled anywhere in the world. They have impressed me with one fact, and that is that they were designed from their inception, they have not simply grown up haphazard. They have a system established, upon which they can put, as they require it, any kind of a surface.

Federal aid is to some extent before us in Canada. Some are extremely anxious to have it; others, as in the United States, are lukewarm on the subject. I believe, however, that it will come in the near future. We are studying the situation. We believe in investigating the situation before we give the aid rather than to have our investigation after it to find out what was wrong. I believe that you will follow the same policy here, and I can commend to you the proposal of Mr. Parker that the matter be placed in the hands of a committee which will have sufficient time and resources at its disposal to decide upon a plan which, after it is carried out, will not require any further investigation. I thank you. (Applause.)

THIRD SESSION

Wednesday Forenoon, December 10

PRESIDENT HILL: Ladies and Gentlemen: The time has arrived for beginning the proceedings this morning. The first number on the program this morning you will find on page 4; the subject is Organization, continued; No. 3, "The Relation to Each Other of the Contractor, Engineer and Inspector." The paper is by Mr. F. L. Cranford, road contractor, Brooklyn, New York. I have the pleasure of presenting to you Mr. Cranford.

THE RELATION TO EACH OTHER OF THE CONTRACTOR, ENGINEER AND INSPECTOR

By F. L. CRANFORD
Road Contractor, Brooklyn, N. Y.

Beginning less than one hundred years ago with the construction of the first steam railroad, nearly coincident with which was the building of the steamboat, the other great factor of modern transportation, there followed an increasing volume of engineering work not only in America, but in all the great countries of Europe.

During the last twenty-five years the amount of construction work has been so enormous in volume as to make the previous performance by comparison little and unimportant. There has been in addition to a vastly increased volume, a great advance in skill in design and construction, in the application of scientific principles and methods and in the adaptation of machinery upon engineering work.

With this evolution, and coincident with it, there has come a development of the contract system now in general vogue by the national, city, county and state governments, and also by the great corporations which brings into relation the engineer, the inspector and the contractor, and the works which these three agents are now performing are probably the most enduring contribution to this particular period of our civilized development.

It would seem to me fair to go a little further. The last century is no doubt going to take a very important place in the history of civilization, but its importance is not political. The great constructive political work in this country of our revolutionary period was in the eighteenth century and our civil war period was rather the correction of an error in the work of the seventeenth century than a constructive period of its own. In philosophy, literature and art there has not been any development which would eclipse for instance the Elizabethan period, but on the contrary, the nineteenth century's great work has been scientific and scientific along many lines—agricultural, mining, mechanical, electrical, medical and surgical. But in no instance has the development been greater and the results so stupendous as in the engineering work witnessed in the construction of our railroads, canals, and water powers, city building, road building, harbor development, etc.

The organization which, in the main, performed this work, was the contract system with which we are all familiar, and, therefore, the relation to each other of the engineer, the inspector and the contractor, who may be said to constitute

this organization, is a very important factor in the machinery of our present day civilization.

Within the memory of many still actively engaged on public work, the duty of the engineer was limited to the drawing up of the plans and specifications for work and his relation to the contractor and to the work was largely that of a surveyor, giving lines and grades and making estimates. The inspector in many instances was not a subordinate of the engineer, but reported directly to the executive officer in charge of the work and frequently owed his place on public work to political considerations rather than to any knowledge, experience or ability that he might have had. The executive also exercised a very much greater measure of control over both the contract and the contractor. The abuses which grew out of such a system were many and of such serious proportions as to threaten for a time the stability of the contract system. It is only a few years ago when the corruption which grew out of this imperfect organization was so great as to throw a stigma upon all who were associated with public work.

With the perfecting of the organization which has largely taken public work out of politics and placed the engineer in charge, there has come, particularly to our cities, the only important advance in our municipal governments, and it is a fair statement to make that this advance is due to the engineering profession.

The dominance of the engineer on our public work developed a conflict which raged with more or less severity between the practical and the theoretical, and this conflict has been the important cause of most of the differences and disputes between us.

The rule of thumb and the theoretical formula will always be a source of contention between the purely scientific engineer and the practical man, the former being skeptical of the value of the rule of thumb and the latter contemptuous of the theory of the engineer. When, however, both have had sufficient experience to allow them to grasp the fact that theory and rules of thumb spring from the same source, if they are correctly interpreted, they will not be so far apart.

Engineering is an exact science, and its theory is, therefore, a formula tabulated from practice. The only difference between a formula and a rule of thumb is the formula's more scientific form.

As an example of the relationship between the scientific and the practical take a trip into the wilderness. What

science will enable a man taken without previous experience out of our colleges or cities and placed in an unbroken wilderness to secure food and clothing and shelter? How quickly will he turn to the native, or even to the savage, for the practical help essential to his very life. The technique of the Indian in his skillful approach to, and let us say, capture of a deer, and the various forms of knowledge required for the use of its flesh as food and of its hide as clothing and shelter, are no more remarkable nor less worthy of respect than the experienced practical man's skill and knowledge upon engineering work, and yet the remarkable Indian hunter is still a savage and his tribe will so continue without the scientific knowledge essential to civilization. So also the practical men must work with and under the scientific.

The contractor, as the practical man, has found during the last two decades an increasing necessity for technical knowledge for the success of his work and a great improvement along these lines has already been accomplished. Is it not just as, if not more, essential for the technical man to acquire a better and more sympathetic knowledge of the practical?

An engineering work is an economic problem, always; and the economical design and execution of any given piece of work must of necessity be greatly affected by the many practical considerations of its location with respect to transportation, labor, supplies and the geological formation and of the technical and mechanical skill needed in its execution. The scientific engineer will not find the success he owes to his work or to himself without a proper knowedge of the practical problems involved. If the engineer's scientific knowledge is not of use to produce better work for less cost with proper relation to future development, it has been misdirected.

The young engineer just out of college, placed, as he usually is, as a surveyor, lineman, or draftsman, without authority or responsibility except as stated, is, I am convinced, not given a fair chance to acquire either the scientific or practical skill needed in his profession.

There is a noticeable difference in the number of inspectors employed on public and private work, political considerations being still visible as a cause for this difference. A large number of inspectors is not helpful, but practical skill and experience are necessary to proper inspection. It has been our experience that a small number of inspectors have not only been of assistance to hold within proper limits over-

ambitious foremen, but have been of great assistance in matters of more importance, namely the safety of the work, the public and the workman—questions which have received too little attention in the past, as the percentage of preventable serious accidents on public work has shown. Some believe it to be as high as 50 per cent., while the percentage of preventable minor accidents is much greater.

A little less politics and more responsibility will strengthen the inspector in our organization just as it has benefited the engineer. It may sound somewhat strained to talk about curbing politics with regard to inspectors, contractors being so free from such contamination, but seriously, there is no doubt that political considerations were the important cause of writing into our public work contracts and specifications the usual iron bound clauses in which the contractor surrenders any and all rights he may have as a citizen or under the laws and constitution of the state and nation calculated to hold him, his successors, assigns, and his heirs to perform without cost any foible or eccentricity of the engineer and of which the engineer is the sole judge.

Let me read two clauses from contracts for the construction of the New York subway:

The specifications and contract drawings hereinafter mentioned and taken in connection with the other provisions of this contract, are intended by the Board to be full and comprehensive, and to show all the work required to be done. But in a work of this magnitude it is impossible either to show in advance all details or to precisely forecast all exigencies. The specifications and contract drawings are to be taken, therefore, as indicating the amount of work, its nature and the method of construction so far as the same are now distinctly apprehended. The railroad is intended to be constructed for actual use and operation as an interurban railroad of the highest class, adapted to the necessities of the people of the City of New York. The contractor shall construct and complete the railroad in the best manner, according to the best rules and usages of railway construction, and if in the specifications or contract drawings or in the provisions of this contract, any detail or other matter or thing requisite for such construction be not mentioned, nevertheless the same is deemed to be included, and the contractor hereby undertakes to do the same as part of his work hereunder. And it is expressly agreed that the price to be paid to the contractor as herein prescribed includes full compensation for every such detail, matter and things.

To prevent disputes and litigations, the engineer shall in all cases determine the amount, quality, acceptability, and fitness of the several kinds of work and materials which are to be paid for under this contract; shall determine all questions in relation to the works and the construction thereof, and shall in all cases determine every question which may arise relative to the fulfillment of this contract on the part of the contractor. His determination and estimate shall be final and conclu-

sive upon the contractor, and in case any question shall arise between the parties hereto, touching the contract, such determination and estimate shall be a condition precedent to the right of the contractor to receive any money under his contract.

Could there be a greater compliment paid to a man than the engineer pays the contractor that tackles such a job? I'll answer that myself. Yes, the compliment to the engineer paid by the contractor when he signs that contract.

A specification for any given piece of work has an underlying and fundamental meaning, it is a description of how to secure the construction with given materials of the best character of work obtainable, and the relation which we bear to one another is largely governed by it. If the meaning be ambiguous and the requirements vague, it is very easy for the relations to degenerate into an effort to see how much each can get away with; a greater simplicity and a larger measure of fair dealing would seem to me to point to a great possible improvement.

While the unlimited authority given to the engineer to interpret and finally determine the meaning of the contract provisions is in practice nullified, first by enlarged estimates to meet the risk of an improper decision and, secondly, by the enforced decisions of our courts holding that this power is really not conclusive, still some method should be devised which will not only limit this seeming arbitrary power of the engineer to make or break a contractor, but will also retain his authority to control and direct the progress of the work.

Public work in the United States is largely now upon a very high plane of accomplishment. Our great private work has been heretofore free from scandal and corruption, but curiously our organization (that is, the contract system, or the engineer, the inspector and the contractor) is, in this particular, I believe, today in greater danger from these causes upon private work for great corporations than upon public work.

The work of the Panama Canal is an illustration, and the only great illustration on which our organization did not work together. My belief is that it only proves the rule as an exception and that the elimination of the contractor in that instance was proper and best.

The twentieth century is just well started and looms big with opportunity, for we have done and are doing great work.

PRESIDENT HILL: Gentlemen, before you take up the discussion of this very interesting paper I am requested to

announce that at the close of this session a group picture will be taken in front of the building.

We expected Major Crosby to be here and open this discussion, but he is prevented by being unexpectedly required to appear in court this morning; and, to obviate this difficulty, he kindly sat up last night and wrote out a resume of what he would have said if he had been here, and that paper has been intrusted to Professor Blanchard, of Columbia University, who will read the paper. Ladies and Gentlemen, Professor Blanchard. (Applause.)

MAJ. W. W. CROSBY (Chief Engineer, Maryland Geological and Economic Survey, and Consulting Engineer, Baltimore, Md.): Mr. Chairman and Gentlemen: These meetings have often been subject to congratulations on the character of the papers presented to them, but seldom, the speaker feels, have the causes for felicitations to the author and to the meeting been greater than in the case of the valuable paper just presented so skillfully and competently by Mr. Cranford, an acknowledged expert in that important subject, "The Relation to Each Other of the Engineer, Contractor and Inspector"; and the speaker can do no less in introducing his discussion of this paper than to in this way call attention to his appreciation of Mr. Cranford's efforts in the matter.

With many of the statements of Mr. Cranford the speaker agrees most heartily; and, as a matter of fact, it is not so much with the idea of criticising Mr. Cranford's statements that he offers his remarks, as with the idea of accenting certain points made by Mr. Cranford, the importance of which appears to the speaker to warrant such accent.

Of course, it is not now necessary to defend Mr. Cranford's remarks concerning the limitation of the duties of the engineers to the drawing up of the plans and specifications for the work and the appointment by other parties, for political or outside considerations, of inspectors on the work. The present recognition of the general desirability of having the inspectors a part of the engineering organization, and of having the latter in charge of the work from its conception, through its performance and to its conclusion, relieves any necessity for argument on this point. It may be safely said, in this connection, that the present tendency is to place more and more authority for work connected with engineering under the control of the engineering head because of the benefits to be had thereby in so many ways.

With this increase of authority to the engineer, there should, and does, come in most cases the proper recognition

by the engineer of his responsibilities in the matter, and in such cases an important problem for the engineer to solve is how to organize the engineering forces so that his duties to the public or his employers on one hand may be responded to fully and equally on the other hand with his duties to his employees—including among the latter the contractor—for the work.

The engineer in charge cannot, of course, personally attend to every detail, no matter how competent he may be in his line of work or as an individual, and it becomes necessary for him to delegate certain authority to subordinates and to require of certain subordinates their assistance in keeping him informed as to the details of the work under him. It therefore becomes imperative for the chief engineer to consider carefully the amount of authority to be delegated in each case and the amount of demand to be placed on the subordinate in each case.

The authority to be delegated should be delegated without any "strings tied to it," i. e., the chief engineer should not delegate to a subordinate the power to accept work and then reserve the right to reject that work when so accepted. It is unfair to a contractor to tell him that he is to satisfy a resident engineer, but that the satisfaction of that resident engineer does not prevent the chief engineer from rejecting the work which is satisfactory to the resident engineer. If the chief engineer cannot trust the resident engineer's judgment, and is not willing to be bound by it, he should state so frankly to the contractor and advise him that the resident engineer's approval of the work may mean nothing in so far as the obtaining of the final approval of the chief engineer to the work goes.

This of course means that the chief engineer must be careful in his selection of the parties to whom he delegates authority and that the delegation of authority will depend upon his judgment as to the capabilities of the subordinate; but, as the subordinates are named, employed by and responsible to the chief engineer, there is nothing unfair to the chief engineer in demanding that he give his most careful consideration to the matter.

An inspector is supposed to merely act as the eyes of the chief engineer in order to inform the latter concerning the details of certain particular work on which the inspector is stationed. To give an inspector authority to control or modify the work is to make him something more than an inspector, such, for instance, as a resident engineer or an engineer-inspector. Unless the inspector possesses, in the

opinion of the chief engineer, ability and judgment, from education and experience, sufficient to warrant the delegation to him of certain limited authority, such authority should not be delegated to the inspector and the exact position of the inspector as to his authority or control over the work should be clearly understood by all parties connected with the work. As said before, when authority is delegated to the inspector it should be definite and the delegation should be lived up to fully.

In the experience of the speaker more difficulties between the engineering department and the contractors have arisen out of the delegation of too much authority to an inspector incompetent to properly exercise such authority, or from the delegation of authority to subordinates with a string tied to that authority in the shape of a more or less complete denial of delegation, than from other causes. The speaker has seldom found it difficult for competent engineers and contractors to get along harmoniously together, although occasionally personal difficulties, misunderstandings, and the like, will temporarily interrupt the harmony. But, on the other hand, a great deal of discord will be found to originate in the attempted matching of a smart and able man on one side with a green and incompetent man on the other side.

The speaker heartily agrees with Mr. Cranford in the desirability of closer association of the scientific and the practical man, and he believes that a better appreciation of each other will quickly follow a better understanding by each of the other's viewpoint. He agrees further with Mr. Cranford that a great improvement along these lines has already been accomplished and that more seems likely to follow. Mr. Cranford's remarks about less politics in engineering work being desirable will not, of course, be disputed, nor will it be disputed, the speaker thinks, that improvement will result in every case where concentration by both parties to a contract of all their energies toward the proper performance of the contract is encouraged and had to the greatest possible degree by the elimination of all improper motives for its performance.

Mr. Cranford's quotation of certain clauses from a very important contract recently submitted to bidders brings again to the attention of his listeners a strong argument against lump sum contracts. It is true that occasionally this form of contract seems unavoidable, but it is hard to defend any contract which places one or both parties to it in the position of gamblers betting on chance. The speaker

agrees with Mr. Cranford that specifications should always be as clear and definite as it is possible to make them concerning the work required to be done and concerning the duties of each party to the contract, and his strong predilection concerning any details of work, impossible of specification in advance, is for a provision in the original contract of opportunity for a proper supplemental agreement concerning the unforeseen work or details. The speaker is well aware that the opportunity for supplemental contracts has in some cases been abused, but he thinks that this abuse has not, in the long run, been more unsatisfactory to the public or to the engineers and the contractors than have the lump sum contracts, so-called; and he further believes that a possible abuse of the opportunity for supplemental agreements suggested as above to be provided can be reduced to the minimum through proper provisions in the original contract.

In a lecture before the graduate students in highway engineering at Columbia University the speaker made the following statements which seem to him will bear repetition here:

One of the important duties of a chief engineer is that of acting as arbitrator or referee on questions of interpretations of the specifications. The courts have again and again decided that the essential of the execution of a contract is its substantial performance in all respects. The over-performance of one detail does not necessarily justify the under-performance of another. The literal carrying out of any specification cannot be insisted upon unless it can be shown that the literal performance is, in the honest judgment of the engineer, necessary in order that the expected value of the detail may be had. As to what is not a substantial performance of a contract, a high court has said: "A contract is not substantially performed by substituting, for that which is expressly required, materials, methods of workmanship which, in the opinion of the contractor and his experts, are 'just as good' unless the substitution relates to a matter of minor importance, is made in good faith, and for sufficient reasons, and there is an adequate allowance for the difference." As to what is a substantial performance in any case, it will depend on the peculiar circumstances of that case.

But enough has probably been said to indicate the legal side of questions likely to arise. Such are less likely to arise where the specifications are full and complete. Again, in such cases, there will be far less opportunity for any questions to come up for arbitration except those concerning substitutions. And these latter are then the most easily handled.

On all questions the decisions of the chief engineer must be based on equity and fairness. His employers have employed him to produce certain results and have arranged for certain assistance to him for that end. He is obligated to secure those results at a fair cost to his employers. He is also under obligation to be fair to his assistants. It is for him to decide, or

should be, what a fair return is for the pay given. Upon his judgment in this respect depends much of his reputation as an engineer. Simply because he has a contractor in a tight grip does not authorize his squeezing anything unfairly out of him any more than is he justified in requiring one or more of his employees to work at low rates because they happen to need the particular positions they hold.

It is quite possible that undue emphasis at the conventions of this association has been laid upon the friction between engineers and contractors. As a matter of fact, most engineers and contractors will readily agree that the friction is only infrequently of a serious nature and that it by no means cuts the figure in the relations of contractors and engineers that possibly this discussion might lead the lay public to believe. Out of the vast amount of work done by contractors under engineers, only a very small percentage of the questions arising ever goes to the courts for settlement, and this matter of friction between engineers and contractors always reminds the speaker of the story of a man who, annoyed by the croaking of frogs when he wished to sleep, made arrangements with a certain commission merchant at a definite price for the sale of a carload of frogs' legs. When he went to accumulate the legs for shipment, he found himself obliged to telegraph the commission merchant that he could find but half a dozen frogs' legs to ship him, although he assumed from the noise they made he would have no difficulty in getting a carload.

The speaker thinks there can be no question but what the relations of the engineer and his subordinates with the contractor will be carried on with the least possible friction by the closest mutual understanding of the duties and responsibilities of each and by the expression in the specifications, as far as may be necessary or practicable, clearly and without ambiguity of such duties and responsibilities and of the details of the work itself.

PRESIDENT HILL: I express the opinion of all present in thanking Professor Blanchard for reading the paper which he has, and I am sure you also recognize the fact of the great debt of the association to Dr. Crosby for taking the pains and the time to write out the paper which has just been read. Major Durham, Chief Engineer of the Bureau of Highways, New York, will take up the discussion of the question. Ladies and Gentlemen, I take pleasure in presenting to you Major Durham. (Applause.)

H. W. DURHAM (Chief Engineer, Bureau of Highways, Borough of Manhattan, New York, N. Y.): The story is told of two London cab drivers who found themselves

opposed in a traffic blockade. When one had exhausted his vocabulary of epithets, a bystander inquired: "Why don't you answer him back?" "How can I?" was the retort, "he has used all the best words."

I am in somewhat the same condition as regards supplementing Mr. Cranford's paper with any remarks of my own. In the first place, it needs no answering back, and I shall not attempt any refutation of the thoughts he has so clearly set forth. In the main, I am in entire accord with them.

There is at present so slight a line of demarcation between the engineer and the contractor, so frequent a changing from one side to the other, and so often an occupancy of positions in both fields by the same man, that there is not much room for the arguments of the old platitudes which were once used to express what the extremists in both lines of work, so-called practical and theoretical men, assumed as definitions of each other. We still have with us, however, the young enthusiastic technical graduate, who expects to find the contractor constantly endeavoring to cover up poor work; and we shall be fortunate if we can conserve his enthusiasm and ideals, while teaching him that the successful contractor is not trying to leave monuments of poor work behind him, and that it is not always necessary to shut down a job because every stone in the concrete may not pass the standard ring. On the other hand, we also have in equal numbers the practical construction man, who thinks no inspector can judge work who has not carried it on for ten years and whose idea of conserving his employer's interest is to save a bag of cement whenever the inspector's back is turned. I encounter both kinds too frequently to regard the subject of this paper as of anything but extreme importance in bringing out a proper idea of the relations of both parties to the contract.

A contract is a bargain binding on both sides alike, and the ancient rule, "Let the buyer beware," makes essential the inspector. In an ideal commonwealth, with all men equally able and disinterested, the contract would pass by word of mouth and inspection would be unnecessary. But as long as men are human, as long as it is human nature to work for one's own hand more earnestly than for the community, then the inspector and the organization of which he is a part form an essential governor in regulating the mechanism by which great results are accomplished, and in which the contractor is not, as some would say, a necessary evil, but the engine which accomplishes some of the great results for the human race.

It is perhaps sometimes forgotten in the recognition of the greatness of the work of this and the past century that engineering is not a new profession, but is coincident with the dawn of civilization and history, and that its development has been as fair a measure of progress as that of the arts and philosophy. The earliest recorded civilized races have left to history engineering works as great as their accomplishments in other lines. The division of labor between engineer and contractor is equally ancient, for there have always been those with ability to plan and others with the ability to execute.

That the differences which sometimes occur between them are not of recent origin is shown by an extract from the report of Nonius Datus, a Roman engineer in 152 A. D., about some tunnel construction for the water supply of the township of Saldae. Nonius Datus appears to have been one of the type of consulting engineers, not unknown at the present time, too busy to pay the necessary close attention to each of their many interests. His attention to his work was recalled by the following petition:

Varius Clemens greets Valerius Etruscus, and begs him in his own name and in the name of the township of Saldae to dispatch at once the hydraulic engineer of the III legion, Nonius Datus, with orders that he finish the work, which he seems to have forgotten.

"The petition," it is recorded, "was favorably received by the governor and by the engineer, Nonius Datus, who when he had fulfilled his mission, wrote to the magistrates of Saldae the following report:"

After leaving my quarters I met with the brigands on my way, who robbed me even of my clothes, and wounded me severely. I succeeded, after the encounter, in reaching Saldae, where I was met by the governor, who, after allowing me some rest, took me to the tunnel. There I found everybody sad and despondent; they had given up all hopes that the two opposite sections of the tunnel would meet, because each section had already been excavated beyond the middle of the mountain, and the junction had not yet been effected. As always happens in these cases, the fault was attributed to the engineer, as though he had not taken all precautions to insure the success of the work. What could I have done better? I began by surveying and taking the levels of the mountain; I marked most carefully the axis of the tunnel across the ridge; I drew plans and sections of the whole work, which plans I handed over to Petronius Celer, then governor of Mauritania; and, to take extra precaution, I summoned the contractor and his workmen, and began the excavation in their presence, with the help of two gangs of experienced veterans, namely, a detachment of marine-infantry (classicos milites) and a detachment of Alpine troops (gaesates). What more could I have done? Well, during the four years I was absent at Lambaese, expecting

every day to hear the good tidings of the arrival of the waters of Saldae, the contractor and the assistant had committed blunder upon blunder; in each section of the tunnel they had diverged from the straight line, each towards his right, and, had I waited a little longer before coming, Saldae would have possessed two tunnels instead of one. Nonius Datus, having discovered the mistake, caused the two diverging arms to be united by a transverse channel; the waters of Ain-Seur could finally cross the mountain; and their arrival at Sadae was celebrated with extraordinary rejoicings, in the presence of the governor Varius Clemens and of the engineer.

From this bit of ancient history we see that eighteen hundred years ago there was the familiar trio of the engineer too busy to visit his work, the inspector who did not inspect, and the careless contractor.

It is hardly a correct view of the case to regard the control of public work by engineers as a new thing. The course of history shows a succession of instances of engineers who were not only great designers, but great executives and in control of extensive organizations and work. And if there has been until recently a period of undue subordination and lack of responsibility on the part of the engineer for great public works, if the inspection has been carried on as a form of political graft, if the relation of contractors to public work was at one time such as to throw a stigma upon all associated with it—it is rather a phase of current conditions in American history than an example of engineering construction work previous to the present quarter century. Recognition of this fact does not at all detract from the acknowledgment, so well expressed in this paper, of the previously unexampled magnitude to which the work of engineers and contractors has now arrived and the improvement in the standing of both which is taking place at the present time.

An exception must be taken to the author's statement that engineering is an exact science. The Quebec Bridge is sufficient proof that even in the branches of engineering thought to be most exact the unknown quantity is still appallingly preponderant, and no great work can be carried on without the combination of technical and practical knowledge; the former, after all, being only a tool and the latter merely another way of defining common sense, which has not depreciated in value in recent years.

The author's criticism of certain specification clauses follows somewhat the line of argument so ably made by Mr. Murphy at the Cincinnati convention last year. In so far as both of them urge for more clearness in specification writing and for the elimination of vague clauses intended

to protect a lazy or inefficient engineer, there can be nothing but agreement for their arguments. It must be borne in mind, however, when criticising the phraseology of public contracts, that we are passing beyond the territory clearly belonging to the engineer and contractor, and entering that of the lawyer as well, in whose profession the ultimate interpretation of contracts lies. It would seem from the number of bidders on the New York subway work at the present time that there are plenty of contractors willing to pay Public Service Commission engineers the compliment of signing contracts containing the phraseology objected to by the author of the paper.

The time for effective protest against unfair or ambiguous contract and specification clauses is before the calling for bids. While recognizing fully the many vexations frequently endured by contractors from blanket clauses possibly written to assist an incompetent engineer, I cannot regard, without further proof, all phraseology of the type quoted as unnecessary in contracts for public works.

In fairness to both sides of the question, another phase must be noted. I have never had an instance of a contractor objecting to the engineer's use of any options given him under such clauses for the acceptance of work about which there might have been cause to question its exact and literal compliance with the specifications.

I have sometimes wondered, when urged that certain departures from literal requirements gave results "substantially in accordance with specifications," whether or not the contractor would be satisfied to have his final payment also modified to suit the engineer's opinion of what might be "substantially" the value of the work.

There can be no exception to the just grievance contractors have had on too much work against the type of inspectors furnished. This is a matter which is frequently difficult for the engineer on public work to control. The placing of the appointments of such men under civil service regulations by competitive examination eliminated, to a large extent, the employment of men for political and other improper reasons, with consequent opportunities for dishonesty on both sides. But while the rules of the civil service commissions obviate an inefficient and dishonest minimum, they also sometimes prevent attaining an efficient maximum.

Until recently, on municipal work in New York, the tendency has been to maintain a class of inspectors with slight opportunities for advancement, and consequent lack of ambition. At present we are endeavoring to provide

means of promotion for those deserving it and a consequent interest in the entering of this rank by ambitious young men. With all his faults, the young engineer, just out of college, after a little experience and proper restraint, will make a better inspector than the easy-going man with no eye to a future increase of responsibility. We hope we are getting just what the author of the paper suggests—a little less politics and more responsibility for our engineers and inspectors; and we are willing to hope that the same may be true of our contractors.

The author refers to the work of the Panama Canal. It is probably true, as he says, that the elimination of the contractor in that instance was essential. It should be borne in mind, however, in regard to this work, which is frequently held up as a model of engineering construction carried on by the benevolent despot handling a big work more proficiently than could be done by contract, that the despot has also control of all news given out about the work and all the displaying of it to the tourists, and is 2,500 miles away from interference, with no limit on expenditure.

An unfair comparison is made by the public when this construction is held up as exceeding in efficiency the great work that contractors are doing in this part of the world, just as an unfair comparison is made by the public in assuming that the successful completion of the canal is due to the superseding of the civil engineer by the military. As one who was connected with this work for three and a half years from its commencement, who served under all the forms of organization in power there, and who had responsibilities for the design and execution of one-fourth of one per cent. of the total work in value, or about one million dollars' worth of municipal engineering construction, I feel that sufficient acknowledgment is not made of the fact that the civil engineers did all the dirty work, made the Isthmus a fit place to live in, solved whatever engineering problems there were, and turned over to the present efficient military organization the tools with which it has so ably carried on the construction of the canal to completion. Where political and sanitary questions were so closely interwoven with the actual engineering construction, it was probably a proper decision to carry on the work without the further complication of contracts. But that it has been done as efficiently or economically is a debatable question. Certainly no contractor's system would be so inelastic in its prevention of the interchange of materials from one

part of the work to another as to produce a case similar to one with which I am familiar, where, within a distance of a mile, one division was turning 12 by 12 timbers, for which it had no use, into 2-in. planks, while another, which needed heavy posts, was constructing them by the process of spiking 2 by 12's together.

A recognition of the present relations of engineer and contractor recognizes also not only a period of great works of unexampled magnitude, but the passing in large measure of the pioneering period in American history, which includes the time of shirt-sleeve engineering as well as that of shirt-sleeve diplomacy. Acknowledgment of the accomplishment of the period which produced the type of practical man who could report before he received an engineer's plan of a temporary bridge he was to erect over a railway washout that "the damned picture hasn't come yet, but the bridge is up and trains going over it," will include a recognition that we have arrived, not at an entirely new stage, but at an advanced position among the older nations where our work requires the highest development both of science and constructive ability, as well as the tact of great leaders of men in those at its head. The class of engineer who had "no use for any —— gentleman" in his organization is passing.

PRESIDENT HILL: The discussion will be next taken up by Mr. Fred E. Ellis, Manager of the Essex Trap Rock & Construction Co., Peabody, Mass.

F. E. ELLIS (Manager, Essex Trap Rock & Construction Co., Peabody, Mass.): I think that we will all agree that the best results in road building by contract can be obtained only when the engineer and the contractor have perfect confidence in themselves and in each other. When this state of mind exists they will both be working for the good of the road, but anything which tends to or does disturb their faith in each other will be reflected in the work they do together.

I am going to try to show you from a contractor's view what helps to make the relations between the engineer and contractor harmonious, and what makes discord between them and their work. To do this I shall try to show you what goes on in a contractor's mind while bidding on a contract and during construction.

The first knowledge that a contractor has or ought to have that a road is to be let by contract is when he sees the advertisement inviting bids. For the purpose of illustration let us take a case where the location of the work is in a new territory from that in which the contractor has

been doing work, and the contractor and engineer are unknown to each other even by reputation. The first feeling a contractor has upon receiving such an invitation is one of curiosity. He wonders what kind of a country it is, what kind of people live along the road, what kind of roads they have, what kind of roads they propose to have, what kind of engineers they have, what kind of contractors they have, etc. The spirit of competition is next aroused in the contractor. He feels that he would like to put his knowledge, experience and organization up against that of other contractors, and if given a good set of rules and a fair referee he has no fear of the result of his competition. He feels that he can do the work as well as, if not better than, his competitors; but he knows that in order to get the work he must do it at a less cost than his competitors.

The contractor next procures a set of plans and specifications. These are the rules under which the game is to be played. The principal thing which interests the contractor at this time is the kind of road which is to be built and he turns to that part of the specifications which gives a description of the type of road. If the contractor finds that the road is of a kind he has had experience with he enters upon the competition with much greater confidence than he otherwise would. The contractor will find nothing in the specifications which shows any confidence in the contractor either by the commission or the engineer; neither is there anything in the specifications which inspires the contractor with any faith in the engineer.

The contractor next views the location of the work. If he finds that the specifications fit the location, that there are evidences of individual study, that the engineer has taken advantage of the local conditions and he is satisfied that he can do a good job under the specifications, then the contractor begins to have confidence in the engineer. If, however, he finds that the specifications show little evidence of individual study or there are evidences of incomplete surveys taken at unseasonable times of the year when accuracy is impossible, then he has not found much as far as he has gone to plant even the seed of confidence.

The next step for the contractor to take is to get acquainted with the engineer, to have a chance to size him up, to give the engineer a chance to size the contractor up, and to find out in a general way from the engineer how near to the specifications he expects the work to be done; the specifications being drawn so accurately and with so little elasticity that it is impossible to ever build a road to the

letter of the specifications. It is absolutely necessary that the minds of the engineer and contractor should meet before any intelligent businesslike bid can be made. Any bid made otherwise is in the nature of a gamble and not a business proposition. In order that there be no misunderstanding as to what I mean by work not being done in accordance with the letter of the specifications, I will give this illustration.

Almost all specifications contain a clause which reads in substance as follows: "Subgrade shall be true to lines and grades as shown upon the plan." I do not believe that there was ever a road built where the subgrade was absolutely true to the lines and grades as shown on plans. I am willing to confess that if this clause were interpreted literally, I would still be working upon the subgrade of the first state road I ever contracted for, seventeen years ago. The difference in expense to the contractor in trying to obtain absolute accuracy and of doing work approximately within the limits of good workmanship, is very great, and when carried on throughout all the items in the contract, means either a profit or a loss to the contractor. It is on such items as this that the contractor sizes up the engineer in a general way and makes up his mind whether he belongs to the "big class" or the "fussy class," and when this has been done the contractor is in condition to make an intelligent bid—a bid which is based not upon the letter of the specifications, but upon the spirit of the specifications as settled upon when the minds of the engineer and the contractor met. I might add that the bid made up with the so-called "fussy" engineer in charge will be somewhat higher than that with the liberal engineer.

The contractor likes to leave the engineer confident that he understands just exactly what the engineer requires, and confident that he can fulfill the requirements. He likes to feel that the engineer has the confidence of his superiors and that what he says goes with them; that the road to be built is of the engineer's own design and is to be built under his directions without any influence being brought to bear either from within the department or from the outside. The contractor likes to feel that the engineer has faith in him, that if the contract is awarded to him it will be carried out in accordance with the spirit of the specifications in such a manner that it will be a credit both to the engineer and the contractor. The contractor having received the necessary information makes out a bid and submits it to the proper authorities.

The next steps are the awarding and signing of the

contract and the commencement of the work. If the work is done under the personal charge of the engineer the work will go along smoothly; but if the work is not in personal charge of the engineer, there appears upon the scene a third party in the person of the inspector who is mentioned in the specifications under the clause "engineer or others upon whom authority is conferred." If the inspector has been brought up under the engineer or has worked for a long time with him, thinks the same and acts the same as the engineer, there is still no reason to doubt that the work will run along as smoothly as if in direct charge of the engineer. In other words the confidence which existed between the engineer and contractor will exist between the inspector and contractor. The minds of the engineer and contractor having met, the minds of the inspector and contractor will meet on the same lines. If, on the other hand, the inspector is unknown to the engineer, does not understand his mind and his methods, friction cannot be avoided. The contractor has entered upon his contract in good faith and may be carrying out his contract in accordance with the spirit of the specifications and still the work may be interrupted by the inspector. The inspector has for his authority the written specifications. When such an interruption occurs the contractor receives a shock similar to that which a surgeon would receive if he were stopped in the midst of an operation by an inexperienced attendant whose only knowledge and authority were contained in an inaccurate written description of the operation as performed on some other person by another surgeon. He knows the patient will suffer as well as himself. There is this difference, however, the doctor generally receives his pay even if the patient dies while the contractor receives nothing unless the operation is a success. Up to this time both the contractor and the engineer have lived up to the spirit of their agreement, each having mutual confidence in each other. The entrance of the inspector with views different from those of the engineer places the contractor in an entirely different position from that which he occupied when the bid was made up.

The inspector is not alone responsible for this condition of affairs. We all know that the public clamor and demand for improved roads is far in advance of the spread of practical knowledge of good roads construction. Most of the inspectors are recruited from the ranks of students who have been studying exact sciences or from persons whose only knowledge of road construction is contained in the book of specifications. Their knowledge of contractors in

general is limited to what they have read in the newspapers. All being wealthy and dishonest, and having no pride in their work, their only object in doing it is to skin it and get away with all the money possible. The contract and specifications aid him in taking this view. No one has told him that the greatest ambition of a road contractor is to be known in the community where he has done work as the man who built a good road and not be known as the man who made a pile of money and built a poor road. If the measure of a man's success is the amount of good work he leaves in a community and not the amount of money he takes out of the community the road contractor comes very near to being a successful man.

I have tried to show you from a contractor's standpoint what goes to make the relations between the contractor, engineer and inspector harmonious and what tends to make discord. It is plain to see that the cause for discord is in the different interpretation of the specifications; therefore change the specifications. Have the specifications state distinctly what will be required of the contractor and no more. Change the clauses which place the standard of accuracy so high that it is impossible to attain it. Arrange the specifications so that within the limit of good workmanship the contractor has an equal right to his opinion with the engineer. Give the contractor the right to take a claim to court unprejudiced by any opinion previously given by the engineer. Have courses of instruction for inspectors. Have contractors qualify as to experience and ability to carry out work upon which they are bidding. I think that if this could be done it would result in very much better workmanship at less cost and more pleasant relations between contractor, engineer and inspector than we have at present.

PRESIDENT HILL: Now, Ladies and Gentlemen, we are going to hear from Mr. G. S. Webster, Chief of the Bureau of Surveys of Philadelphia, Pa., on the same subject. I have great pleasure in presenting to you now Mr. Webster.

G. S. WEBSTER (Chief, Bureau of Surveys, Philadelphia, Pa.): I have listened with great interest to the admirable paper by Mr. Cranford on the relations of the contractor, engineer and inspector, and I agree with him in many of the views which he expressed. The remarks which I have to make must necessarily be a repetition of some of the discussions that have gone before, but they will be given probably from a new point of view, that of an engineer who has handled municipal work.

To properly discuss the relation which should exist

between the contractor, the engineer and the inspector it is necessary to start out with the assumption that all three are honestly endeavoring to secure materials and workmanship in accordance with their understanding of the terms of the contract which they are carrying out. If the contractor in undertaking any piece of work does so with the purpose of evading the provisions of the contract or of negligently performing his obligations, it is clearly the duty of the engineer to abrogate the contract or to take drastic means to secure a compliance with it. Hence there can be no discussion on this phase of the question.

In the preparation of plans and specifications, the engineer representing the principal to the contract has access to and opportunities for making explorations of the site and examinations of all the conditions which are likely to be met with in the prosecution of the work. The plans and specifications therefore should be complete and set forth clearly every item which will cost time or money and should be so free from ambiguity that no explanation as to their intent should be required in order to make an intelligent bid.

The plans of the structure to be erected, especially if lump sum bids are asked, should give absolute dimensions particularly as to foundations; and responsibility for providing for unforeseen conditions should be borne by the principal to the contract, and in case the full quantity of materials is not required, an equitable reduction made.

The use of general clauses in specifications is necessary, particularly for work done by a municipality where awards are usually made to the lowest bidder, in order to give protection against the incompetent or dishonest contractor and to cover minor details essential for a workmanlike finish, but the use of such clauses for the purpose of exacting from a contractor who bids a lump sum price for work and material about which there is uncertainty, should be avoided, as it is sure to lead to a misunderstanding and probably to litigation. Specifications which require the contractor to agree when he presents his bid to secure at a later date permits and to do work and furnish such additional material as may be required to make the structure acceptable to a department of a municipality, such as a bureau of building inspection, and to include the cost of the same in his bid, work a hardship and sometimes do an actual injustice to the contractor. Instances have occurred where the materials to be added under such requirements have represented quite a considerable percentage of the cost of the work. In all cases the responsibility for including in the

plans and contract the work so required should rest upon the party making the contract and not upon the contractor.

The inspector should be directly under the authority of the engineer and should be appointed only on account of his practical experience and competency to supervise the work, and under no consideration should appointments be made on account of political preferment.

When a piece of work is commenced, the engineer, contractor and inspector should begin it with a frank understanding that it is the purpose to complete the work as set forth in the contract and not with the idea held by soldiers going into battle that each is the enemy of the other, for good work can best be accomplished where there is cooperation of all concerned and by the exercise of judgment and tact.

An inexperienced inspector is a fruitful source of difficulty with a contractor. Where inspectors are trained mechanics and can take hold of a set of tools and skillfully do the work themselves, they are best able to advise how the work should be done and will not place trivial objections which interfere with its progress; and where such conditions exist there is rarely any difficulty with contractors who have a disposition to do their work properly.

Many contractors are enabled to bid low upon a piece of work on account of their skill in handling it and in reducing to a minimum their overhead charges. When a work is about to be commenced, the contractor should submit to the engineer an outline of his methods of procedure and if this does not conflict with the requirements of the contract or do injury to persons or property, he should be allowed to proceed accordingly, and both the engineer and inspector should so plan their duties as to facilitate and not hinder the proper carrying out of the work. The engineer should keep the contractor advised from time to time of the percentage of progress that is being made, so that both will be informed of the probability of the work being done within the time agreed upon.

In order that a satisfactory relationship may exist between the contractor and the engineer, arrangements should be made by the engineer for promptly testing all materials to be used in the work and to promptly pass upon all foundations so that there may be no delay in securing other materials, if necessary, or doing such work as may be required to allow the work to proceed. The tendency which some engineers and inspectors have on the least pretense to stop a piece of work or to totally change the contractor's program

for carrying it on when there is no violation of the contract or no public interest suffering, is sure to cause dissension and is an assumption of authority which no contract can justify. On the other hand, the contractor should have on the work at all times ample material, machinery, pumps and appliances to promptly meet any emergency which may arise—to prevent injury to the work or damage to private property.

The contract should definitely set forth the rights and duties of both parties and if, after efforts have been made to avoid uncertainty, a dispute should arise, or if there should be honest differences of opinion between the engineer in direct charge of the work and the contractor as to the intent of the plans and specifications, the matter should be referred to the chief engineer or some other competent arbiter for adjustment; for the engineer, however carefully he may have prepared the plans and specifications, may be unconsciously prejudiced in his belief that they set forth more clearly than they really do the work to be performed.

The placing of discretionary power in the hands of the engineer cannot be escaped and the fact that but few of the many thousands of contracts executed annually reach the courts for final settlement indicates that this power is not abused, but that it is exercised with judgment and with equity to all concerned.

PRESIDENT HILL: Gentlemen, the discussion will be next taken up by Mr. Wm. M. Acheson, Division Engineer of the New York State Highway Commission. Is Mr. Acheson in the room? (No response.) Mr. Acheson does not seem to be here at this moment. That, therefore, will close the discussion, unless someone desires to speak on the subject, and the meeting will be turned over to our Second Vice President, Mr. W. A. McLean, who will conduct it during the progress of the discussion on convict labor, which next follows. I have pleasure in presenting to you your presiding officer and Second Vice President, Mr. McLean, who will take the chair. (Applause.)

CHAIRMAN McLEAN: At this hour I do not wish to trespass upon your time nor upon the time of the following speakers by placing before you any introductory remarks. Let me say, however, that I cannot pass the occasion without thanking your President for the good will which he expressed in his opening address yesterday for Canada, the country which I have as my home. Let me assure you that expressed in his opening address yesterday for Canada, the Canada has many good features, and we believe that one

of these is that we have such a good friend to the south of us.

Your President referred to the 100 years of peace which is just coming to a close. It is the feeling throughout, not only Canada, but the British Empire, that a friendly federation of all the English-speaking people is the greatest guarantee which we can possibly have for the future peace of the world (applause) and the turning of the useless armaments of war into the channels of peace which we so much require. One of these channels is the building of good roads (applause); and I know of no better way of promoting social intercourse between our countries than to make the entrances from one country to the other passable for all who will travel over them. (Applause.)

The subject which we are to discuss is that of convict labor. It is one which most highway experts feel heartily interested in today because of the tendency from time to time of causing us to view the situation not simply from the outside but from the inside. I will call upon Dr. Joseph Hyde Pratt, State Geologist of North Carolina. (Applause.)

DETAILS OF ARRANGEMENTS FOR THE USE OF CONVICT LABOR

By DR. JOSEPH HYDE PRATT

State Geologist and Engineer of North Carolina

Before taking up a discussion of the details of arrangements or organization for the use of convict labor in the construction of public roads, I wish to state briefly certain phases of the convict labor problem that are pertinent to the economic use of such labor. There are certain fundamental principles that must be borne in mind in considering this problem and in the handling of convict labor.

First: The convict is a human being and must be treated as such; he has a sense of responsibility, honor and discipline, and this sense can be quickened and developed.

Second: Perhaps with few exceptions, there is some good in every convict, which can be developed and made paramount in the character of the man.

Third: The convict in serving his sentence is simply paying a debt that he owes to the state for certain infringements of the laws of that state; and, when he has served this sentence, he has paid his debt and should be in a position to become a good and valuable citizen of the state. Most convicts are serving a first sentence and often for a crime committed on the spur of the moment, and with many

of them this one crime committed represents the only black spot in their lives.

Fourth: Hard work is a good reformer, and idleness begets melancholia.

Fifth: The state on her part owes it to the convict to assist him in every way to pay his debt as speedily and economically as possible, and in such a way that he is a better man when his debt is paid than when he was convicted.

Sixth: The attitude of the state toward the convict should be corrective and not vindictive; to uplift and not degrade him.

Seventh: To put a man in stripes often so degrades and humiliates him that it is extremely hard, and sometimes impossible, for him to reform.

Eighth: Outdoor work is much more conducive to good health and cheerful dispositions than confinement in prisons or factories with no outdoor exercises but what can be obtained in a limited area of a penitentiary yard or court.

Ninth: There must be an incentive before good work can be expected from most convicts.

Tenth: There is a great variation in the character and working ability of different convicts.

Eleventh: In many cases a family was dependent upon the convict before his sentence and is, during his sentence, deprived of that support.

The first question that presents itself is whether the attitude of the state toward the convict should be to impress upon him that he has committed a wrong and therefore there is no good in him, and that this idea must be impressed upon him continually during the serving of his sentence; or whether the attitude of the state shall be that the convicted man in serving out his sentence is paying a just debt to the state, and that, while she insists the debt shall be paid and that in paying it the convict shall not forget that he is a debtor to the state, yet she will eliminate as far as possible the fact that crime has been committed. Is it possible for the states to have this latter attitude toward the convict when they compel him to wear stripes—which in America universally denote the felon—have their heads shaved, and always walk in lock step when going from one part of the prison ground to another? These phases of a convict's life were formerly considered necessary in order to prevent his escape and were also considered as part of his punishment. They are degrading, and will wear out the soul of many a man; and, to my mind, should only be used as a last resort and not as a first resort. I believe depriving a man of his

liberty and requiring him to work for the state for a certain length of time according to the gravity of his crime is sufficient punishment for a very large majority of the men who are convicted.

At present, without going into the question as to what is the best work for the convict to do, I wish simply to make the general proposition that in any group of convicts it will always be found that some will do a great deal more and better work than others, that some will work very willingly and industriously, while others are lazy and only work the minimum amount that is required of them. This is especially true of a certain class, when they feel that they have got nothing whatever to gain by more energetic endeavors. Would it not then be the proper thing for the state to allow the convict a certain percentage of the value of his labor, which could be forwarded to his family, if he has one dependent upon him; or become accumulative and be given to him at the end of his sentence as a fund with which to start life anew?

The state is the guardian of every convict and she can make or break him according to the treatment she measures out to him. Her rules and regulations must be just, and then she must insist upon strict obedience to them. On the other hand she must be just as strict to see that those she places in charge of the convict, whether it be prison warden, superintendent or foreman, all keep faith with the convicts and that all promises made to them of whatever character are kept. A promise to the convict is an obligation that the state must keep, and upon the strict carrying out of such promises and the strict enforcement of just rules and regulations will depend the success of the use of convict labor not only in road construction but for any other purpose.

Keeping in mind the suggestions and statements made above, I would submit for your consideration as a logical plan for the treatment and organization for work of the convict the following:

That the men who have been convicted and sentenced for the first time all be considered as men capable of being treated in the most lenient way by the prison authorities. That they should not be required to wear stripes or have their heads shaved, reserving this form of prison garb for those whom it was found could not be trusted, and who would not live up to the rules and regulations of the prison authorities.

There could be three classes of convicts: Those in the first class, who are not required to wear startling or very

noticeable uniforms; those in the second class, who are required to wear a distinctive uniform but not stripes; and those in the third class, who are required to wear stripes and, if necessary, have their heads shaved.

To the third class would be assigned those who had been convicted and sentenced more than once for some crime against the state, and also those who while serving out their sentences constantly broke rules and regulations of the prison authorities.

To the second class would be assigned those who had started in the first class but had shown that they would not obey all the rules and regulations or do good or efficient work and were not to be trusted; and for further infringement of the rules and regulations, they would be assigned to the third class. To this second class would come men from the third class who had shown by their work and their deportment that they were trying to live up to the rules and regulations and become better men. They in time might be able to be transferred to the first class.

To the first class would be assigned those who had been convicted for the first time, and they would remain in this class until they had shown by their behavior that they were not to be trusted or would not do good and efficient work, when they would be assigned to the second class. In this first class would be the men who would be known as "honor men."

In the South where a very large proportion of the men convicted of crime are negroes, it may not be possible to carry out exactly the above classification, as it may be necessary to assign the negro convict to the second class and make him show by his work and deportment that he is entitled to a place amongst the "honor men." In the West and probably in the North where the negro convict is in the minority, it is possible to assign them at once to the first class. To some it may seem that guns are necessary to control the negro convict, yet I believe it will be found possible to create in his mind the idea and realization that the serving out of his sentence is simply paying a just debt that he owes to the state, and that the state is really trying to better his condition and give him a chance to make something of himself again; and that this will develop in him a loyalty to the superintendent of the camp and the foreman under whom he works.

The convict force would be divided into the above classes regardless of the work that they were to do. The present paper, however, takes up the question of the use of this

labor in the construction of public roads, which means the erection at various points of convict camps.

Organization of the Convicts

The organization of this convict labor for road construction would be by two distinct methods depending upon the classes of convicts used:

First, would be the convicts that would be worked without guards and without stripes, representing the men of the first class or "honor men."

Second, would be those over whom it was necessary to have armed guards while they were working, and would be convicts of the second and third classes.

The men of the third class would wear stripes and work under guards with guns, and the worst men of this class might have to be worked in stockades in breaking rock or doing similar work. Those of the second class would be worked under guards with or without exposed firearms, as the case might be. At night the convicts of class III would be on chains and under armed guards, while those of class II would not be on chains but under armed guards.

First Method of Organization

The convicts in the first method of organization representing class I or "honor men" would be divided into three groups, if the camp were of sufficient size, according to the work that the men were capable of doing. In the first group would be the most efficient men of the camp of whom would be expected a certain definite amount of work. The rest of the convicts of the camp would be graded into second and third groups. Knowing then what each group of men was capable of doing on an average as a day's work, the foreman of the road work could estimate what each group should easily be able to do in a certain time; and then, if the group were able by especially energetic work to accomplish more than the required amount, the men of that group should be allowed as a bonus a certain percentage of the value of the extra work that the group accomplished, this to be paid in money and divided equally amongst them. The first group should be allowed 50 per cent.; the second group, 40 per cent., and the third group, 30 per cent. of the values of the extra work. The men should be permitted to spend this money at any time for things they wished, that, of course, were not under the ban of the authorities.

As I have already stated, I believe that the convicts should be allowed a certain per cent. of the value of the time that they are obliged to work for the state. the money thus

earned to become accumulative and to be turned over to them at the expiration of their sentences; or to be turned over, if requested by the convict, at stated intervals to his family; provided that at all times there should be a certain percentage of that earned by the convict to his credit in the penitentiary treasury. These two opportunities of actually earning money would be a very great incentive for the men to do better and more conscientious work, and would also be an incentive for each man to see to it that each member of the group to which he was assigned did his part toward keeping up the record and reputation of the group. The amount allowed to convicts for their labor would vary according to the class to which the convict was assigned. Those of the first class should receive a greater amount per day than that received by either of the other two classes; but each group of class I should receive the same percentage. This would be a fair proposition inasmuch as the cost to the state of the man in the first class would be considerably less than that of those in the other two classes, inasmuch as no guards would be required and the men would be on their honor. My idea is that no matter what the rate allowed per man be, the men of the first class should receive one-third again as much as those in class II; and they, in turn, should receive one-third again as much as those in class III. It would cause the men of the first class to do their best to remain there, as they would be able to earn more money; and it would be an incentive for the men of the third group to try to get into the second group, and for the men of the second group to get into the first group.

The men of the first class would also receive a commutation of their time. This varies in the different states, amounting to as much as ten days in one month in some states. If any man in class I did not live up to what was expected of the "honor men" and broke the rules and regulations of the camp, he might be reduced to a lower group; or, if his offense were very great, he might be reduced to class II, and in the latter case he would lose what time had been commuted. If he attempted to escape he should be reduced at once to class III and would lose not only the time commuted but what money had been credited to him. Thus it will be seen that there would be every incentive for the man in class I to remain in that class; and I believe the men of that class would try and do their part to see that each one of the class lived up to what was expected of him. Those in classes II and III would see the great benefits that came to those in class I, and would begin to do what they could to be transferred to class I.

The accumulation of money that the convict had earned and the accumulation of time commuted from his sentence which he knew would be lost if he attempted to escape or if he constantly broke the rules and regulations of the camp would be one of the strong motives that would prevent him from trying to escape; and, as will be seen later, this would also apply to the men of the second and third classes. To my mind, however, one of the strongest motives that would keep the men in class I would be the fact that confidence had been placed in them and they were trusted.

It might be well at this point to state that any community that undertakes the working of convicts along the lines I am outlining must make it a point that "honor men" must be "honor men" in every sense of the word. There must be no guards of any sort. They must be housed, treated, worked, and fed similarly as in a military camp or perhaps in a railroad construction camp; differing from the latter, however. inasmuch as there would have to be certain rules and regulations similar to a military camp that the men must live up to; such as retiring and getting up at certain specific times, being regular at meals, and other regulations that would be laid down by the warden or superintendent of the convicts. It is in this way that the convict realizes to the fullest extent the confidence that the state is placing in him and is believing that he will respect this confidence and pay his just debt by serving out his sentence.

Second Method of Organization

In the second method of organization where it would be necessary to have the convicts guarded, the organization would be somewhat different than in the first. In the first place we would have two classes of convicts, one of which (class III) would consist of the men that had shown for the time being at least that they could not be trusted in any way and had to be worked in stripes under armed guards and chained at night.

Class II also would have to be worked under guards, but it will be found that in some instances, as will be noted later, it would not be necessary that these guards carry exposed firearms. The men of class II could be divided into two groups. Those of group 1 would be considered men who were on probation before being transferred to class I; and, while they would still be worked under guards, it would not be necessary for these guards to carry exposed firearms. Group 2 would be worked under guards carrying exposed firearms, but without chains. At night all the men of class II would be in camp under armed guards. Those

of group 1 would not be on a chain while those of group 2 would be. These men of class II would wear some distinctive uniform, but not stripes. The men of class II would be allowed a certain percentage in money of the value of their labor which, however, would be one-third less than that received by the men of class I, and there would be no bonuses allowed for any extra work. The men in group 1 of class II would have the advantages over group 2 of not being under guards with exposed firearms, not being on the chain at night and being in direct line for transfer to class I. This, I believe, would be incentive enough to keep these men from breaking the rules and regulations of the camp. Group 2 of class II would know that by good behavior and good work they would be able to get transferred to group 1 of the same class and in the end to class I.

For infringements of the rules and regulations and for any attempt to escape, they would be punished similarly as stated for the men of class I.

The men of class III would be divided into two groups. Group 1 would be worked on the public roads but under guards and if necessary with chains. At night they would be under strict guard and on the chain. Those of group 2 would be men whom it was not considered advisable to work on the public roads, and would be worked in stockades under armed guards and, if necessary with ball and chain. Those men could break rock for macadam, make cement drain tile, or do other work that could be done in a stockade. With good behavior the men in class III would be transferred from group 2 to group 1, and then from group 1 to class II, and so on to class I. They would also be allowed for good behavior a commutation of their time and a certain per cent. of the value of their labor in money. This, however, would be considerably less than that received by the men in class II.

The one idea embodied in the above suggestions is that the rules and regulations of the camp and penitentiary authorities must be obeyed, but in obeying these the convict becomes entitled to and receives special consideration by the state.

The commutation of time would be the same for all classes of convicts; provided, of course, that they lived up to the rules and regulations of the camp to which they were assigned.

The organization of the men who would handle the convicts would be of a two-fold character: First, the men taking charge of the physical body of the convict; and, second, those having charge of the labor of the convict.

The superintendent of the camp should have charge of the feeding, clothing and guarding, when necessary, of the convict. He should also be responsible for sanitary conditions of the camp and for the care of the sick. He should provide the guards, when necessary, but these in no case should be permitted to act as foremen of the road work.

The superintendent of the construction work would have charge of the labor of the convicts, and he should, through his foreman, direct such labor; and it should be performed as he wished it. He and the engineer of road work of the state should decide the amount of work that the convicts ought to do and determine what men should be in the three groups of class I. The division of the men into classes should rest with the penitentiary authorities, but the superintendent of the work who came in close contact with the convict might from time to time recommend changes, and should report the refusal of any men to work as directed, which would constitute an infringement of the regulations of the camp.

It would not be necessary to work all the "honor men" of class I in one camp, but certain numbers of these could be transferred to other camps where they would have special sleeping quarters, and would do such work as blacksmithing, bridge and culvert work, and other work where only one to three men were required and where it would be very expensive to provide a special guard for so few.

The question comes up and is often asked: Can long-term men be put on their honor and, as in the suggested organization, be placed in class I? Can they resist the temptation to escape? I believe many long-term convicts can be worked as "honor men" and in class I of the suggested organization. I believe that with a large percentage of them, there would be less yielding to the temptation to escape if they were in class I than if they were in class II or III under armed guards.

These questions, however, of classification would be settled by the warden or superintendent, and they could usually determine pretty accurately who should be trusted. As I have already stated, except in extreme cases, I believe men sentenced for the first time could be started in class I (with perhaps the exception of the negro convict). By personal contact, the prison and jail wardens come to know the prisoner and to know something of his character. I believe another good plan is for the superintendent and warden to get in touch with the prisoner's kinsfolk and get them in sympathy with the work of the prisoner and in having him serve out his sentence.

The prisoner's family should be encouraged to keep in touch with him, and should be permitted to visit him at stated intervals, and thus encourage him in every way to pay as rapidly as possible his debt to the state and encourage him in the feeling that there is a place for him when his sentence expires.

Convict Camp

The convict camp would vary in its construction according as it was to be occupied by men of class I or by men of class II or class III. If the camp were to be occupied entirely by men of class I it could be established very similarly to a railroad construction camp. And there is no need of my going into any description of such a camp, except to state that it must be sanitary.

Wherever the camp is located and by whatever class of convicts it is occupied, it must be kept in a sanitary condition, supplied with pure water, and facilities provided for the men to bathe. All camps should be under the supervision or inspection of the State Board of Health.

Where camps are to be occupied by men of class II, there are many plans that are in use for accommodating and taking care of the men. One camp I might describe used by state convicts in North Carolina, who are working a road in Henderson County, would be descriptive of one type of camp.

This camp, which is located near Bat Cave on the bank of Broad River, Henderson County, consists of a bunk house, or, as it is sometimes called, a "cell house" 30 by 60 ft., in the center of which is a double-deck platform called the cell, upon which are arranged the beds of the convicts. There is a clear space of 12 ft. between each end of the building and double platform, and 6 or 8 ft. clear between the cell and the side walls. The space between the two platforms is approximately 5 ft. Each man is allowed a single mattress, so that he has plenty of room for sleeping purposes. Four chains run the length of the platform cell, one each side for the lower tier and one each side for the upper tier. To these chains the convict is fastened by a light-weight ankle chain at night. This is so arranged that there is little or no weight on the ankle and he can turn in any position he wishes while sleeping. The construction of such a bunk house depends on the time of the year and length of time it is to be occupied; but it is always built so that there is plenty of air circulating through the building and that it may be kept warm and comfortable in cold weather. Guards are on duty in this building at night, one at each end.

Near to this building is the dining hall, kitchen, and store house. Surrounding these two buildings and enclosing an area of about one-fifth of an acre is a six-strand barbed wire fence. Just outside of this fence at opposite corners armed guards are stationed during the day. At night the only guards are within the bunk house. The sleeping houses for the superintendent, steward and guards are a little distant from the enclosed area. The food supplied to the prisoners is the same quality as that supplied the guards and the steward. It is necessary that pure, wholesome food, clean and well-cooked, should be furnished to prisoners, and that is what this camp tries to do.

In a camp of this sort, the men of class II would have free run of the building and of the area within the fence during the daytime, but at night those of group 2 would be fastened to the chain, while those of group 1 would not. Cots could be substituted for the platform, but in that case only one-half of the number could be accommodated, increasing the amount of floor space required and the number of guards.

Another type of sleeping quarters consists of tents with one platform along each side of the tent with a clear space of about 10 ft. between the two platforms. Where a camp is to be moved frequently, the tents are very convenient as they are easily taken down, transported and set up again.

The bunk house or sleeping quarters of the Virginia convicts consists of a canvas tent or tent-shaped building of sheet iron. Two rows of cots are placed in the center of the tent, and the men sleep with their feet toward the center. Along the line of cots is a long chain to which the convict is fastened by light-weight chains.

As these road camps have to be moved at frequent intervals, it is economy to have them constructed in such a manner that they can readily be taken down, moved, and set up again.

Although the convict camps are to be under the supervision of the State Board of Health and certain definite rules regarding sanitation, cleanliness, etc., will be enforced, yet there should be a physician who would visit the camps every so often and examine the men to observe their physical condition. Where no such physician is employed by the state for this purpose, arrangements should be made with a physician living in the vicinity of the camps to do this work. Every effort should be made to keep the men in good health and no pains should be spared to this end. The men, realizing that their health was being looked after by the state,

would be more and more impressed with the idea that the state was trying to make men out of them, and would do more themselves to carry out the policy of the state in regard to its treatment of its convicts.

There should also be a chaplain to look after the spiritual welfare of the convicts, and it is a good plan for the state to employ a regular chaplain for this purpose. It would, of course, be impossible for one man to visit all the camps or convicts each week, but he could readily arrange with clergymen in the vicinity of the camps to hold religious services every Sunday. I do not believe in making attendance on these meetings compulsory, but am confident that a very large majority of the men would attend such Sunday services.

As stated above, the sanitary conditions of the camps of all the classes should be very carefully looked after, and the mattresses, bedding and clothing kept clean. But in addition to this the convict should be encouraged in every way possible to keep himself neat and his individual part of the bunk house neat and trim. Chairs and benches should be provided around the bunk house.

Reading matter should be provided, and it would be found that a considerable proportion of the convicts would appreciate this very greatly. Donations of magazines could readily be obtained to be sent regularly to the camps. Circulating libraries could be secured at little expense.

Colorado, Oregon and Washington are states that are using convicts of class I in public road construction, but as yet are not using convicts that will correspond to class II.

Virginia is working her convicts as class II with the two groups. At nearly all the Virginia convict camps, there is a certain number of "trusties" that are trusted absolutely, representing group 1, and the balance of the convicts represent class II.

The difference in the cost of the work is all in favor of Colorado.

Georgia has the second class without stripes and third class with stripes.

Arrange so that the convict can build the roads and the roads will rebuild the convict.

CHAIRMAN McLEAN: The program announces that this discussion will be continued by Major P. St. J. Wilson, State Highway Commissioner of Virginia. As Major Wilson is not here, the next speaker will be Mr. C. M. Kerr, Assistant Engineer, State Highway Department of Louisiana.

F. M. KERR (Assistant Highway Engineer, Board of

State Engineers of Louisiana): When the Highway Department of the State of Louisiana first came into official being, upon the morning of February 6, 1911, little had been previously done by the state to further the cause of good roads. In fact, previous to the year 1909, rural road effort, in Louisiana, was mostly confined to spasmodic spurts of energy on the part of individuals, parochial authorities, communities and others, each on its own responsibility, and each in its own peculiar way, with limited means, striving simply to accomplish something somewhat more advanced than Nature had already vouchsafed them.

In this year, under a broad proposition, advanced by the governor of the state, in the absence of state organization, an understanding was reached by which the state should furnish the services of the Board of State Engineers for all engineering work, and the forces of the State Penitentiary for construction work; the police juries of parishes should furnish funds for the actual expenses incident to same, and the United States should furnish superintendence along model lines. This resulted in many excellent road projects being proposed and executed during the following year—so much so, that, at the session of the General Assembly of the state in 1910, a law was passed requiring the Board of State Engineers to assume, under certain conditions, control of the highways of the state; to employ a highway engineer; to define his powers and duties, and fix his compensation; to authorize the construction and maintenance of highways by contract or by the Highway Engineer; to provide under certain regulations, for the working of convicts on highways; to authorize, by expropriation or otherwise, the acquisition of rights of way for highways, drainage canals or ditches; to provide revenue for carrying out the objects and purposes of the law, and for the disbursement thereof; to require the parishes, cities, towns and villages to contribute a certain proportion of the costs of construction and maintenance; and definitely defining the meaning of the name, "state highway."

One of the most valuable provisions of this law soon developed in the fact that the state's convicts could be utilized upon its highways, enabling the consideration of projects otherwise, by reason of inadequate means, practically prohibitive; it being demonstrated that when properly organized, equipped, directed and handled, such forces offered the most direct, systematic and economical method by which to arrive at comprehensive results.

Unfortunately, the life of the demonstration was, from

causes over which there was no control, of only short duration.

Other works of public improvement upon the construction and maintenance of which the state was immediately more vitally concerned demanded the withdrawal, for at least the time being, of the convict forces from highway work.

Particular reference is had to the construction and maintenance of the public levees of the state which, by reason of two successive periods of extreme high water in the Valley, entailing more readjustment than usual, had to be given precedence over all else.

Therefore, at present, all work in progress by the Highway Department is being prosecuted under contracts or by force account, and while, of course, the standard of efficiency is in every respect maintained, the funds so far available to the Highway Department of necessity cannot reach as far nor accomplish as much by possibly as much as one-half that which would be possible with convict labor under the conditions already outlined herein.

When the demand for convict labor in the other fields described becomes less exacting and imperative, it is hoped that the Highway Department may again enjoy the benefit of its services, thereby again permitting this form of aid to the parishes of the state, and the greater benefits to be thereby derived.

Whether the aid extended by the state be monetary, or through its convict forces at actual cost, the first step to be taken by any parish desiring state aid is to make application to the State Highway Department therefor, upon forms specially prepared for the purpose. This application must be supported by a resolution duly passed by the police jury of the parish, setting forth its financial status and ability to meet its obligations, and binding itself to abide by all the requirements prescribed by the Highway Department. Having, through the Highway Department, secured the services of a convict force, the parish is required to promptly supply a suitable camping outfit, including living quarters, and a complete equipment adapted to road building.

In the employment of convict labor, the first outlays are generally the most extensive, involving as they do the preparation for its care, which should be the best, and the equipment, which should be the most modern and up-to-date. This, however, may with equal justice be said in regard to any class of labor, whether it be free or otherwise. Undoubtedly, the best returns can be looked for only in con-

junction with proper consideration and proper treatment. The closest attention to the quarters of the men, and to their upkeep is imperative, while all sanitary measures and hygienic requirements should be strictly followed and observed.

Again, a convict force, to give the best results, must work as a unit, with a governing head. To fill this position, requires special experience in dealing with this class of labor, and, in selecting anyone for the position, due regard should be had as to whether or not the person selected be a good judge of human nature. The man selected for such a position is generally known and styled as the "captain" of the force. He must be a strict, yet just, disciplinarian, whose business it must be to preserve order, govern the men, see to it that everything runs smoothly, and that efficient service is obtained. A captain has under him a sufficient number of foremen and guards, the duty of the foremen being to direct the men while at work, while the duty of the guards is to preserve order and prevent the escape of any one disposed to attempt it.

By far the greatest percentage of convicts in Louisiana consists of negroes, who, when properly governed and directed, rank second to none as laborers. Some, who may recognize the error of their ways, and, by good behavior have won the confidence of the authorities, become what are termed "trusties," and are allowed considerable latitude. Unfortunately, however, there is always, as well, the incorrigible, who, under the name of "gunman" is constantly kept under close and strict surveillance.

From the foregoing, it will be seen that in the government of a convict force, power is vested in one head, with all necessary aids and assistants.

The housing, clothing, feeding and general maintenance of a convict force is in itself a problem. Suitable quarters must be supplied for the captain, assistants and guards while off duty, and a sanitary, well ventilated cell-house, large enough to accommodate the full force of convicts is absolutely necessary. While the captain, assistants and guards can ordinarily be cared for in tents, an inclosure of a more substantial character must be provided for the other quarters. The latter structure will largely depend upon circumstances. The moving of camps is a very important item, and generally a comparatively costly one, especially if the nature of the work in hand requires rapid movement or progress, such as simply repairing improved highways, or the construction of the simpler class of roadways, where the constant change

of camp is necessary to insure reach without too great a loss of time. In such cases, in fact, convict quarters should be as light in structure as practicable, and easy to erect. Where permissible, in lieu of one large cell-house, several smaller compartments should be substituted, placed upon trucks so that they may be easily and quickly moved from place to place, materially reducing cost. After living quarters have been fully supplied, attention should be directed to the necessary accessories to camp life, such as a covered dining room, for use especially in bad weather; then a complete commissary, with a competent clerk in charge, usually a white convict, and a well furnished kitchen. All of the latter can be housed in tents.

In regard to the equipment for actual road work, besides all necessary implements and tools for handling earthwork, clearing right of way, building bridges and culverts of all kinds, the purchase of which brings the initial outlay to quite a sum, a sufficient number of live stock should be added. A camp of 50 laborers should have at least ten teams, which means an expenditure, at the very outset, of at least $5,000. None but the very best class of stock should be considered, slip and wheeler work requiring large heavy animals. For the care of this live stock, still further camp equipment, in the form of stables, barns and the necessary fencing for a corral, is necessary. With one more addition, a practically equipped blacksmith shop, a camp may be rated as complete and prepared to accomplish efficient and economical work, provided all departments interested act in unison and harmony.

Under the methods in practice in Louisiana, the Board of Control of the State Penitentiary, the police jury of the parish interested, and the Highway Department—three in number—are the departments to which reference is made.

The duty of the first is to furnish the labor, with captains, assistants and guards of its own selection, the captain constituting the representative of the board on the ground.

The duty of the captain is to handle the labor in all its details, and to direct all routine work attached to the camp.

The duty of the police jury, after equipping a camp in full, is to supply all funds necessary to keep the camp going, and to furnish all bridge and culvert material, or any other incidentals that may be needed.

The Highway Department should establish all locations, formulate all plans and specifications, and have entire charge

of the actual road construction, including all details connected therewith, under an engineer assistant, who, under the direction and supervision of the State Highway Engineer shall make all necessary surveys in connection with the location of a highway, and have direct charge of all operations in the field, the captain being under him and required to carry out all orders emanating from him.

With the foregoing described system in operation, and everyone interested working for a common cause, an important problem, I think, may be claimed to have been solved.

Lack of sufficient funds with which to carry on the work of constructing improved, if not model, highways, on a proper scale, is the greatest obstacle in the path of the good roads movement in Louisiana. If a system, whereby the cost can be reduced to a minimum, and the contractor's profit eliminated, can ever be introduced and maintained, the highest standards may yet be lived up to, and a tremendous stride made along ambitious lines. To me, this is rendered possible by convict labor.

With this labor, one has at his command, well fed, well clothed, healthy, able-bodied men, on hand at all times, and to be depended upon for value due, in vast contrast to the shiftless, ill nourished, undependable free negro labor upon which contractors in Louisiana must of necessity mostly depend.

In Louisiana, about 175 miles of improved highways have been so far constructed with convict labor. Except for about 12 miles of gravel road, all of the work thus done has consisted of earth and sand-clay roads. The saving, through this form of labor and expenditure, as compared with similar work performed by contract, has ranged from 40 to 60 per cent. Had these highways been of a higher class of construction, thus not necessitating such constant moving of camps, it is firmly believed that a still greater saving might have been effected. As it is, earth and sand-clay roads have been constructed under the system current in Louisiana, at from $750 to $1,000 per mile, while the gravel surfaced roads cost on an average of $4,000 per mile.

A camp of 50 men should be allowed the following superiors:

1 captain, at $75.00 per month	$75.00
3 foremen, at $40.00 per month	120.00
5 guards, at $30.00 per month	150.00
Total	$345.00

An approximate estimate of the cost of equipping and running, for road purposes, a convict camp, based upon a force of laborers numbering 50, would be as follows:

10 teams, at $500.00	$5,000.00
10 road slips, at $7.00	70.00
1 road grading machine	200.00
1 road roller	2,000.00
2 road drags at $20.00	40.00
1 blacksmith outfit	50.00
All necessary axes, picks, shovels, etc	100.00
Tents for living quarters, dining room, stables, etc	500.00
Kitchen outfit	50.00
Lumber for cell-house, etc	500.00
Incidentals	500.00
Total	$9,010.00

From actual experience, it has been ascertained that the cost of maintaining and operating one convict per year in Louisiana, is about $170, or between 45 and 50 cts. per day.

It would thus appear that every inducement to further the use of state convict labor upon the highways of the state was held out, and it is greatly to be deplored that the opportunity to demonstrate beyond cavil its great value proved so short lived.

CHAIRMAN McLEAN: Gentlemen, Dr. Moore, Superintendent of the State Reformatory of New Jersey, is here and cannot be here this afternoon, so we will hear from him for a few minutes.

DR. FRANK MOORE (Superintendent of the State Reformatory, Rahway, N. J.): I appreciate very much the excellent paper to which we have listened, and wish to emphasize particularly the thought that the writer gave us that road camps should be camps of honor. It seems to me that chains, balls and enclosures of barbed wire really have no place, rightly, in our road work, and that when a man is put out on the road to work he should be put out strictly on his honor. If we do that we have a means of keeping him from running away that is stronger than can possibly be secured by means of guns or chains. (Applause.)

We had a little experience at our New Jersey Reformatory on our farm. We had a detail on the farm, and one man was designated as the trusty of that detail. There were frequent runaways from the farm with one man as trusty, but by and by the instructor in charge of that detail made up his mind that he would make every young man in his detail a trusty, and when a bucket of water was wanted or some tools were required he would not call for one particular man to go, but for the nearest one at hand, who would be sent to get whatever was needed. Since that plan has been adopted there has not been a single runaway

from that detail, because every fellow felt that he was on his honor. (Applause.)

This system of honor works well. We have sent 50 young men to funerals all over the state of New Jersey, dressed them up in citizens' clothes, given them the money and sent them out to stay all night and come back, and not a single one of them has failed to return who has been thus trusted. The whole situation, it seems to me, is more in the officer who is in charge than it is in the gun or the ball. The boys say of certain officers, "I wouldn't run away from him because he is white, he treats me white, and I wouldn't go back on him." The primary consideration, therefore, it seems to me, is to get officers who are respected by the inmates, who deal fairly with them. When the inmates feel they are dealt justly with they will deal fairly with the officer.

I would suggest that it would be a wise thing to do away with the term "guard," because if you use the term guard you are constantly saying to the inmate or the convict, if you please, under that man: "We are expecting you to run away and here is a man that is going to guard you from running away." If we should change that word, for instance, to boss or to manager, or to foreman, it would be a great improvement. I like the word "foreman," and I differ a little bit with the gentleman from North Carolina; I believe that the man who is sent by the prison to take charge of the detail should be a man who is skilled in road work, who knows how to do road work and who goes out with his gang of men just as any foreman would go out with that gang, and says to them, "This is the work to do." He shows them how and he pitches in with them and practically becomes one of them, and they have a greater respect for him; they know that he knows something, that he knows his job, that he is not sitting around idly watching them as if they were going to run away, but he is really a foreman working with them. That kind of man is not only more successful in keeping the custody of the convicts, but he is an economical proposition because you do not have to have a foreman and guard as well. (Applause.)

Then I would suggest that we must never forget that the important thing is not the road but the man. (Applause.) More important than any road built in any state is the rebuilding of the character of the man. (Applause.) You go into a factory and see all its wonderful machinery, but you know that back of that machinery is a more wonderful

thing than that machinery itself, and that is the brain of the man who planned and invented that machinery. Always the most valuable thing that we have to deal with is the man and not the material thing.

Never forget also that these men are weak morally, or they would never have gone to the penitentiary or reformatory in the beginning; therefore we must handle them in the most careful way. I would say that it is important, it seems to me, that no prison authority should arbitrarily say to a man, "You must go and work out on the road." The man himself should have the choice whether he goes out to work on the road or not. I have had experience with boys whom I have trusted and they have come in to me after a while and said, "Dr. Moore, I want you to bring me inside the walls; I am afraid of myself; I'm afraid that if I stay out in that detail I will run away." And, having a knowledge of themselves, therefore, they should have a choice. Besides that, we must not forget that those who work on the roads work out in a public way, where the passerby on the highway can see them. Therefore the man who has come into the custody of the law perhaps because he was weak mentally or because he has had an inherited weakness or because society has failed to succeed with him, when that man goes out on the road he should go out because he says, "I am willing to go"—not because he is forced to go, having the possibility not only of being punished for the crime that he has committed, but having the possibility of the additional disgrace that might come to him in being seen out on the road.

I would say, too, that there are certain kinds of men to whom this work is particularly adapted. We find in the New Jersey reformatories that 33 per cent. of our men are feeble-minded and cannot learn a trade that requires skill. But they can do this kind of work, and it is particularly adapted to them; and I believe it is particularly adapted to the class who are given to drink, who need the exercise and who need the stimulant, or soporific influence of the outdoor life.

I do not belive in stripes on the road; I do not believe in the ball and chain. I think if we put these camps more on the honor system than on a system like this we would find they would be more coveted by the man behind the prison walls as an opportunity to have a healthy amount of employment; but I do believe most thoroughly in that which the gentleman from North Carolina advocated, namely, compensation for the work that a man does on the road which is above and beyond the cost of his maintenance.

When I became Superintendent of the New Jersey Reformatory we had two contract labor shops where men who were money-graspers were making money at the expense of boys who were laboring all day long in what was practically a sweatshop. Those employers were paying to the state less than fifty cents a day for their labor. We soon saw there was no possibility of reform in that kind of employment and did away with that kind of work in our institution. (Applause.) About a year after that New Jersey passed a law which made it illegal for there to be any contract labor inside of any penal institution of the state of New Jersey, but that law has not gone far enough. If it was not right for two contractors to make money out of boys who were in the shops—if it was not right for two citizens of the state of New Jersey to make a profit out of those with whom society had failed and who were incarcerated—then it is not right for the state of New Jersey to make money out of the man who is behind the bars. (Applause.)

And when the state does make money out of him then that convict has the feeling that the state is unjust with him; and we find that most of the men who fall, fall because they feel that society has been unjust towards them. They resent the injustice that they feel they have been subjected to and they commit the crime and become imprisoned because of that. Now then, if the prison deals with them, taking their labor and paying them nothing for it, in such a way that they feel that the prison is unjust to them, they still have that resentment towards society which makes them determined to continue to be criminals after they have gone out of the institution; therefore, in order to teach them that society is just we should pay them wages when they earn them behind the bars. Moreover, by means of paying them wages we demonstrate to them that they have the power of getting on in the world. Some of them feel that they can never succeed; but, if, while they are in the employ of the state as convicts, they can earn money they get confidence in themselves and they feel that they can succeed, and they go out with that feeling of confidence that has been gained while the state has been handling them.

I want to emphasize another thing, and by that to make a claim for the rights that the citizen has, and that is this: You know, or everybody who handles convicts knows, that the convicts working on the road and in other places, when they are fairly treated, give more work per day than does the average citizen employed in these jobs. (Applause.)

PRESIDENT HILL: That's true; I know it.

MR. MOORE: Because of the fact that they are not subject to drinking at night, perhaps, or cannot spend their nights riotously, they have the strength next day to go to work. Now, then, if they give more work per day than the average citizen does, in the name of all that is just it does seem to me as if they ought to share in the profit which they produce. And not only this, but when a man gets his money for the work that he does he has the means, as has been suggested in the paper, of helping to relieve the sufferings of his family, which oftentimes is the greatest sufferer because of his incarceration. This plan of paying wages will not make the cost of maintaining the criminal any greater but will, in reality, make it less. He will work harder and earn more. I thank you. (Applause.)

CHAIRMAN McLEAN: We haven't time to continue the further reading of papers on this subject, but, as our President, Mr. Samuel Hill, has had so much experience with the question, I think we should not close without hearing from him. (Applause.)

PRESIDENT HILL: I thank you, gentlemen, but I don't think I will take your time; you are all hungry; you are like the rest of the convicts, you all want to eat. (Laughter.)

CHAIRMAN McLEAN: I am sorry Mr. Hill won't speak; but after this is over there will be a photograph taken out at the main entrance; and I will ask you all to meet there. I would especially call attention to the state exhibits, the other side of this room; if you have not been in there, by all means go in and see them, for it will pay you; also the tent exhibit, where the heavy machinery is located on the outside—don't overlook that.

FOURTH SESSION

Wednesday Afternoon, December 10

PRESIDENT HILL: Continuing the discussion on convict labor, the next speaker scheduled is R. J. Potts, Professor of Highway Engineering, College of Texas. As Prof. Potts is not here, we will call on Mr. T. J. Ehrhart, State Highway Commissioner of Colorado. While we are waiting for those gentlemen to come in, I am going to give Mr. Vermilyea, President of the Ontario Good Roads Association, an opportunity to speak about matters for next year; he wanted to be heard on this subject. Ladies and Gentleman, Mr. Vermilyea.

N. VERMILYEA (President, Ontario Good Roads Association): Mr. President, Ladies and Gentlemen: While I have the distinguished honor this year of being President of the

Good Roads Association of Ontario, I am a common farmer and, as such, not accustomed to addressing public audiences. Indeed, in my own country, I never do so except apologetically, and I think, when I am asked to address such an audience as I see before me today, that I might, with singular propriety, solicit your pity.

It is a treat for me, after an absence of about 35 years, to come down to Philadelphia to visit the people of the United States. I see a great deal that interests me, I see wonderful progress on every hand, and the thing that strikes me, Mr. President, very forcibly, is the similarity of the two peoples, the Canadian people and the American people. Our institutions are slightly different; you live under another form of government, but you are children of the same mother, England, and we should not have any serious differences at all. We are accustomed to speak of you as our American cousins. I object to that—you are our American brothers. (Applause.)

And that is the spirit that is being inculcated in Canada among all thoughtful people. As the Vice President of this association said this forenoon, what a pity that the money spent on military preparations, upon the drill and the building of dreadnoughts, can not be spent in peaceful pursuits, can not be spent on the highways of this country. Why should Americans and Canadians quarrel? Why should we shoot each other down? We are never going to. (Applause.)

We have a common literature. We think alike on almost all lines. You revere and respect the flag of the United States; so do we the flag of England. You are attached to your institutions; so are we. Here we live along a boundary line, you on one side and we on the other, and I defy any man who visits the state of New York or any of the border states, to tell the difference in speech or in any other respect between a Canadian and an American. We admire your literature very much. The poems of Longfellow have always been an inspiration to me. The writings of Bryant and of Emerson and Washington Irving and Whittier, the king of them all, are an inspiration to every good man. The nation that produces such public men as Washington and that grandest production of the United States, Abraham Lincoln, and Garfield and McKinley and Wilson, must be a great country. We acknowledge your greatness and we are sorry that we are divided in any sense.

However, I did not come to address you today at all at length, but to convey to you from the association of which I have the honor of being president the most cordial invitation which we are capable of extending, to hold your next

annual meeting in the city of Toronto. It will do you good and it will do us infinite good. We are undertaking the same task you are and we have the same difficulties before us. We know how to build roads and so do you—the difficulty is to get the money. The difficulty is to make the government feel the importance not only of building roads, but of spending money continually in their maintenance. We repeat to you, we ask you, Mr. President and gentlemen of this convention, to consider it very carefully if you will in the interests of that good feeling that ought to exist between nations—we ask you to hold your next annual meeting in the city of Toronto. Toronto is the convention city of Canada; its people cannot help being cordial, they cannot help entertaining—it is their peculiarity. Come over and test it. (Applause.)

PRESIDENT HILL: The very cordial invitation extended by Mr. Vermilyea on behalf of the Toronto association is received. I think it would be very proper for some one to make a motion to refer it to the proper authority, so it can be acted upon.

[A motion to refer the matter to the proper committee was made and passed.]

PRESIDENT HILL: Gentlemen, Colonel Washington.

COL. WM. DeH. WASHINGTON (New York, N. Y.): Mr. Chairman and Gentlemen: It is a privilege to meet you and to say a word or two on a question which I think is one of the most important that is before this convention, that is, the utilization of convict labor for road building. I may touch upon one or two points and give you a little information on the subject that you have not had before, that will accentuate the necessity and the reason for the utilization of this labor from other than the economic standpoint.

This question of convict labor is almost as close to my heart as it is to the heart of your distinguished President, and I am going to say, before I go any further, that you want to hear him, because he is the apotheosis and the encyclopaedia of all learning and knowledge on the question of convict labor and its utilization, and this convention will miss a treat if, through his modesty, you do not insist on his speaking.

But to take up my own little thread, I want to tell you a few things, to begin with, of the situation in our prisons. A great many of us from the Eastern States have heard of the utilization of convict labor in Nevada, Colorado, Washington and the West, but we have had a sort of nebulous

idea that it was inapplicable to the East, and to the convict situation in the Eastern States. People would say, "Out in Colorado a fellow gets out in a desert or prairie and there is nowhere for him to run to, and the same thing is true of Nevada and Washington." But I am going to tell you that in the great state of New York, dotted with towns and villages and containing the Adirondack and the Catskill Mountains, which furnish the most excellent opportunity for a man to hide himself, during the last year, Judge Riley, head of the Department of Prisons, told me yesterday, we have had 450 different men sent out upon our roads in the State of New York—sent out upon honor. And how many escaped? Just two, and both of them came back of their own volition. So if we are afraid of the problem, I think that demonstrates the possibility of utilizing convict labor in the East in a way that it has not been demonstrated before. These men were not chained, they were not put under guard; they were simply placed purely and thoroughly upon their honor. In the state of New York, when men of good reputation in the prison—what might be termed "trusties," in the descriptions of a number of the speakers—are sent from one prison to another, they are simply given a ticket and told to go and deliver themselves up to the other prison, and there has not been a single man escape or offer to escape, nor have any of them taken advantage of the trust that was put in them. There is a good deal of truth in the saying that there is a good deal of good in the worst of us and a good deal of bad in the best of us, and some of us don't give a fellow who has had a little shade cast over him the credit for any good.

Let me tell you a little about the situation in our prisons in New York; and it is probably true of all prisons. In the first place we are sorry when we go into a menagerie and see an animal confined in a cage about 12 ft. long and 8 ft. wide. We think of the poor beast confined there. Do you stop to realize that that is about twice if not three times the size of the cage in which we confine our fellow human being when we send him to a penal institution? Do you realize that when we commit a man—or a woman either—in a great many of our states, no matter what his condition is, no matter what his family ties are, it is true in New York and I suppose it is true in Pennsylvania, that for two weeks he can neither receive communications nor communicate with his friends and relatives.

Do you realize that in many of our states the rule of silence is preserved for 23 hours and 45 minutes of the day?

That a man or woman who goes into the prison has got to remain absolutely silent, without speaking to a human being, for 23 hours and 45 minutes, and for 15 minutes of the day only can they converse, in a guarded way, with their fellow prisoners or human beings? Is that the kind of a situation that gets the bad out of a man or increases the bad in him?

We have got a play in New York at this moment which is one of the most interesting things I have ever seen. It was written by a man who was in prison for a number of years, a very famous prisoner, Roland Molineux, who was accused of murder and tried twice. The first time he was tried, no defence was put in and he was convicted; and the second time he was tried, he put in a defence and it was proved that he was many miles away from the place where the crime was committed, or rather from the place where the package that conveyed the poison was supposed to have been mailed. He was released, but that man spent four or five years in Sing Sing Prison and got to know what prisons and convicts were. He spent about three or four years in the death house, and he wrote a book called "The Room With the Little Door," and if you could read the description given by that man living in the room next to the little door where men were taken out every few days and electrocuted, it would make you realize what the inside of a prison is like. And he has written a play and it conveys a lot of things to me and to a lot of us, and I have no doubt that it is written from his own experience, because he is a man of ability and a man of brains. In this story he paints a picture of the prosecuting attorney's office—and I know it is a true picture, too, because I have been on the grand jury in the city of New York, and our grand jury and the prosecuting attorney's office there are just about the same as in other states or communities. A lot of young fellows go into the prosecuting attorney's office and want to make a reputation as criminal lawyers. I had a case when I was on the grand jury, in which a young chap 16 or 17 years old was brought before us and the district attorney presented an indictment for burglary, for which the penalty is 7 to 10 years in state's prison. The boy was a homeless chap—probably had had nothing to eat for some time—and he went into an areaway and reached his hand into a window and took out a 5-ct. string of beads. And the district attorney wanted to indict that boy for burglary, because, constructively, he had broken in, since he had reached his hand through an open window and taken a 5-ct. string of beads. And if there had not

been some one on that grand jury who was a little vigilant, he might have been indicted for burglary, and, even if he had been acquitted, that indictment would have stood against him and if he had ever committed another offence, he might have been sent up for 20 years as a second time convict. That throws a little bit of light on our laws and the way they are administered.

But, coming back to the point, this man Molineux, in his play which is called "The Man Within"—and he really means by that, the man within the man—one of the young men in the district attorney's office becomes indignant at the way things are handled—that every time the district attorney gets an indictment, he wants to make it burglary or some other felony. And I have seen cases where the most trifling offences had been committed and the district attorney would send those cases in and try to get indictments for some felony out of them—trifling offences as the one I mentioned of the taking of a 5-ct. string of beads which they tried to make burglary of, or a fight, out of which they would try to get an indictment for an assault with intent to kill. This young fellow says, "I am going to try to find out what is beneath; what it is that we are dealing with"; and he begins to investigate and he goes and meets a lot of men and goes to a sort of a thieves' fence and an opium joint and meets a lot of professional thieves there and talks to these men and finds out that every man has a feeling and has gotten into a condition where he believes that the community is at war with him and that the world is against him and that he is against the world. He feels, therefore, that it is a fair fight; and when he takes a thing away from some other man, he is more or less justified in his own mind.

This young fellow works on this theory, and, in the play, of course, it is proven. He takes these various burglars and they have the most realistic talks. These men say "What chance do I get when I go to prison? I am an outlaw now and will always be an outlaw. If I am convicted once, I am an outlaw forever." Finally this man comes to the conclusion that as a man thinks, so he is. That is one of the oldest aphorisms in the English language, and we have created a condition of thought and continue that condition of thought in the minds of many of our convicts. Finally he says—and this is the crux of the situation—that while we have a court of conviction for our people, we should likewise have a court of rehabilitation for a man who has once committed an offence against the community.

That is a mighty big thought and I want to go a little

beyond that: We have today practically no graduation of our punishments. A man is sent to jail or he is sent to state's prison whether his offence be large or small—if he steals a few dollars he may be sent to state's prison. If the crime is not of a very serious character but still an offence against the state, he goes to state's prison, loses his citizenship, becomes a convict and is branded forever. I want to see our laws and our states become liberal enough to modify that situation and, on a man's first conviction, if he has had previous good character and it is believed he is a man that might be trustworthy and rehabilitated, instead of sending him to prison, send him to the roads. Don't make him a convict; don't deprive him of his citizenship and his rights and don't put this stigma on him, but give him an opportunity to re-enter the community as a man and not as a convict and an unreconstructed wild animal. (Applause.) In other words, give our neighbor a chance.

A very large percentage of crimes are committed in anger or in liquor or from some sudden impulse or influence, sometimes from want, but a very large majority of them, I am satisfied, are not committed from innate baseness or criminality. Now we have proven the thing in many cases. There is a most interesting series of articles that has just appeared in the "Saturday Evening Post" called "The Outlaw," written by a man who was once an outlaw and had a most interesting experience. He had committed all sorts of crimes and I believe he is now district attorney or running for district attorney in Oklahoma, and he has got the respect of his community because he has rehabilitated himself, and they have given him a chance. A lot of us are not big enough to give a man a chance after he has once been a convict. We shut a man up in a cell where he has no opportunity to exercise, we unfit him for manual labor and for everything else by keeping him in idleness, and then we turn him out in the community, rebellious against the community and against the very conditions he has been under. I had a great detective tell me in New York on one occasion. "In my judgment, the state commits a greater crime in a very large number of cases, when it first convicts a man, than the man committed against the state, because when we once make him a convict, he is always a convict and he has hardly got a chance, after being forced into contact with the people he meets in prison and then forced out without health, strength, power, opportunity or money except the $10 that is given him to give him a start. He has no references and no chance to get a livelihood."

Let us get these men out on the road; it is the logical place for them. It costs 5 to 10 per cent. of the total expenditures of the average state to support its convicts in penal institutions. Why not make them self supporting and a benefit to the community? I believe in the honor system and I believe it can be carried very much further than any of us suppose, because if these people are treated as men, if they are treated as individuals and not as numbers, they will begin to realize that character counts—it will be a splendid thing, and you can get character in that man if he hasn't had it before, you will build it in him and create it in him. Now, we can make our penal institutions self supporting and relieve that burden on the community. If there is a class of men who cannot be trusted and are considered like class No. 3 that our friend from North Carolina was speaking of today, we propose, as has been suggested by our highway commissioner from New York, to utilize them on road work on the inside, in quarries and brick making plants. In the cost of making brick, labor is about 50 per cent. or more, and that will enable us to make vitrified paving brick in that way and pay the freight for quite long distances and still get the material on a reasonable basis. I believe that every encouragement should be given to this effort, and we can work the honor system and get our roads built much better and by a class of men whom it will benefit infinitely and give them remuneration, compensate them while they are doing it and let them know they can earn money. A lot of our convicts do not know they can earn money.

A lot of our people, perhaps these ladies, shudder at the idea of having these convicts among us and think of the danger of it, but do you realize that every convict in the state of Pennsylvania will be free and thrown on the community in three years—on the average? If there are 5,000 or 10,000 men in your state prisons today, every one of them will be free or another man will be free in his place in the next three years. What have you done to improve that man and make him a safer member of the community? What better can you do than to put him out as a trusty to do work on the roads in your community? (Applause.)

We have just had a unique thing happen in New York. One of our highway officers at Little Falls gathered a number of his friends together and gave a banquet, and they had a lot of these convicts who had been working for them, and when these gentlemen were through, they invited the convicts in and gave them a banquet, and when that was

over, the convicts gave them one of the finest entertainments they had ever had, and all of them sat down and shook hands and had a royal good time. Let us extend the hand of fellowship to our unfortunate brother and help him to rehabilitate himself in the community, because it is God's work and your work and my work and the work of this association, so let us get busy on it and let every man put all the soul and body and energy he has got into this effort, because there is nothing bigger or nobler to be done today. (Applause.)

T. J. EHRHART (State Highway Commissioner of Colorado):* The first convict road labor law was passed by the Colorado Legislature in 1899, and provided a special appropriation of about $20,000 for the experimental use of convicts on road work. This law was opposed by the wardens of both penitentiary and reformatory, and was not entirely successful for the principal reason that untrained, inexperienced men were placed in charge.

The next legislation—known as the "Lewis law"—was passed in 1905 and provides that counties may apply to the warden for convict road labor, agreeing to pay all expenses, including equipment, teams, food and superintendents' salaries, connected with the work. The men are carefully selected by the Warden with regard to their physical ability to labor and as to character, and are placed in charge of superintendents, trained and experienced in handling men of this character. These superintendents must also be expert road builders.

The gangs number from 25 to 75 men, and are fully equipped with tents, necessary teams, etc., at the county's expense. Warm, comfortable, gray clothing, without stripes or distinguishing marks is furnished by the state. The convicts are furnished with an abundance of good substantial food at an average cost of 33 cts. per day per man.

Under the Lewis law the convicts are given ten days credit and the time deducted from their sentence for each month's satisfactory labor. They also receive, in addition, for good conduct one month's credit the first year; two month's the second year; three month's the third year and so on. A five year sentence would thus be reduced one-half. Should a man attempt to escape he loses all credits, and if captured is returned to the penitentiary and will not be permitted to go out on road work again. The only punishment for infraction of the rules is return to the prison and loss of credits. In consequence of these rules the escapes are less

*Written discussion sent in but not read at the convention.

than one per cent. per annum. Remember, these men work without any guards whatever; are entirely controlled by the rules and a capable superintendent, who has an assistant. The superintendents' salaries range from $100 to $125 per month; assistants, $75 to $80 per month and subsistence. The average cost per man per day, including salaries, sustenance, tools, powder, teams, etc., will average about 80 cts.

The work done will compare very favorably with the best up-to-date contract work at a comparative cost, variously estimated at from 50 to 75 per cent. Outside the estimate of monetary gain is the more, in my opinion, important humane consideration in the treatment of the man. He goes out into the open with healthful surroundings, and when his time expires he goes forth in splendid physical condition, capable of taking care of himself at any sort of labor. It is the endeavor of every inmate to so conduct himself inside the penitentiary that he may be chosen to be sent out on the roads. The health of these men while engaged in this work may be marked 100 per cent. The interest and pride in the work done more than equals that of the paid laborer. We have "life-timers" who have worked on state roads for the past ten years. There have been two instances at least where men under life sentences have journeyed alone from their camps more than one hundred miles by stage and train to the state capitol to appear before the Board of Pardons to plead their own pardon cases, afterward returning to their work.

Each camp has a convict night watchman, blacksmith, cook and waiter.

A somewhat unique bathing provision is adopted: A large iron tank is set up on a fire box built of stone and mortar. A small pipe is inserted a foot or so above the bottom of the tank, which is connected to a bath tub inside a tent or other temporary structure. Once each week every man must take a bath, and each must supply his own bath water by filling the tank above the outlet pipe, otherwise he can get no water.

It costs about 20 cts. per day to feed a man at the prison, so that the state saves that amount for each man employed on state roads, or in our state about $60,000 per annum.

The character of the road work in Colorado varies from plain prairie grading to very heavy rock work in the mountains. Our convicts have been employed as a rule in this heavy class of work. They build all culverts and small bridges of concrete.

I know that the Colorado system is entirely satisfactory

from every point of view, the only trouble being that there are not enough convicts to supply the demands from the different counties.

PRESIDENT HILL: This closes the discussion on the question of convict labor. I would say that tomorrow night I will show some pictures illustrating convict labor in the West. The idea of using convict labor in road building started down in North Carolina, as mentioned by Dr. Pratt this morning, but has reached its highest development in the West.

The next subject is Subject B, Construction; and the first paper "Determination of the Amount of Realignment, Grading and Drainage to Be Done in Connection with Road Improvement," is by Mr. S. D. Foster, Chief Engineer of the State Highway Department of Pennsylvania. I have great pleasure in introducing to you Mr. Foster, of Pennsylvania. (Applause.)

DETERMINATION OF THE AMOUNT OF REALIGNMENT, GRADING AND DRAINAGE TO BE DONE IN CONNECTION WITH ROAD IMPROVEMENT

By S. D. FOSTER

Chief Engineer, Pennsylvania State Highway Department

The determination of the amount of realignment, grading and drainage to be done in connection with any road improvement will primarily depend on the amount of money available and the local conditions surrounding each particular section. Any comments or suggestions which I may make in treating this subject will be only in a general and very broad sense, referring more particularly to that class of highways which are in common with those of Pennsylvania.

The highways existing in the state of Pennsylvania may be divided into several classes, namely:

The old Indian and animal trails; the state roads including the provincial highways; the toll roads, or those built by corporations: and the local or township roads.

The first class—the old Indian and animal trails, or roads—usually follow the valleys made by creeks and rivers and run along the line of least resistance, and any change in the alignment will consist, in a great measure, in the elimination of existing crossings or in the necessity of an increased number of crossings of the parallel waterway. Changes will be necessary in order to escape extensive maintenance, due to slips or washouts; on account of the necessity of raising the grade of the highway to a point beyond high

water; and, in order to eliminate the usual heavy grade that we find where a road has followed a valley to its head.

The second class, or state roads, are those highways known as "stage roads" and offer a wide field for relocation, as this type of highway was constructed seemingly without regard to economy, safety or comfort, and, apparently, laid out with a view of obtaining the most direct line between two points. The changes most readily determined on this class of highways consist of relocating them around the bases of hills and along the ridges, thus eliminating the steep grades, with probably very little if any increased length, and at little cost or less cost than the heavy construction work and excessive maintenance charges necessary in allowing them to remain where they are.

The provincial roads, also coming under the class of state highways, need little realignment, except in instances where a relocation is necessary on acount of some foreign development which has caused a divergence from the original alignment; and the amount of relocation and the extent thereof will depend in a great measure on the money available for property damages, as this type of road, owing to its long number of years of use, will be found to traverse sections of the country which have been more or less built up.

The third class—toll roads—were built by corporations and were constructed with economy as to maintenance; and the thoroughness of their construction and the extent to which they were improved were dependent on the expected monetary return from travel over them, and, where competing companies operated, greater attention was given to details of alignment and grade.

The fourth class, or the local highways, were laid out in most part by county engineers and boards of viewers and were surveyed primarily to provide the greatest economy in labor of construction, or were bound, by decision of the board of viewers, to follow existing property lines. In other instances, such roads have been properly located by the county engineer, but, on account of the construction being left entirely to the local authorities, original grades and lines were not followed, and while plan and profile probably still exist, no proper physical location can possibly be made, and the present traveled road has become a permanent highway, and property rights, in many instances, have passed, using the center line of such existing highway as a boundary. In this class of highways, realignment will consist in the abolition of sharp turns and steep grades by correct location, without regard to property lines.

The determination of the amount of grading to be done in connection with the improvement of any highway will depend largely upon the amount and nature of the travel, and the topographical conditions of the country through which the highway passes. Excessive grades increase the cost of transportation and also add a heavy burden of maintenance, and it is always advantageous to lenghten a road and eliminate an excessive grade. This as a whole, should be governed by the following axioms:

1st. No greater load can be moved over a highway than can be moved over the maximum grade.

2nd. It is generally true that a road over a hill is equal in length to one around the base.

3rd. If the tendency of the topography is toward a continued elevation, the grade line should never be allowed to have a descending grade, and vice versa where the tendency of the topography is toward a lower level.

With the first thought in view, it is well to thoroughly investigate the highway which is to be regraded with the idea of deciding between what local points the greatest amount of travel exists and upon the heaviest grades between such points and then determine the equitable distribution of such money as you have available for the elimination of grades, as it is my theory that it is always best to expend the larger portion of money available in reducing the maximum grades and expending as little as is consistent with general conditions upon the lesser grades.

With the second thought comes the ever-present fact that steep grades increase both the cost of transportation and maintenance and are to be eliminated wherever possible, even to the extent of adding additional length to the highway. In a study of the relation of grade to distance, the actual loss of energy in transporting a load should be taken into account; and we would probably find by calculation that it would require as many foot pounds of energy to lift one ton one foot vertically as it would to move one ton horizontally along a road surface—which offers 100 lbs. of tractive resistance—a distance of 20 ft. Theoretically, but not altogether practically to save one foot of grade the road may be lengthened 20 ft. without any additional requirement of energy in moving a load over it. It will be readily seen from this reference, that needless rises in the grade of a road demand wasteful exertion, and that unnecessary length added to a road causes loss of time and money.

Needless detours and heavy grades use up the energy of engine or team and represent a dead loss to a community.

All things being equal, a road should be straight and have as light a grade as posible; consequently, the time and labor expended in traveling over it would be the minimum. But in a hilly country a road can not well be straight and of a light grade at the same time, and in such cases the sacrifice of straightness, or of grade, will be dependent upon the predominant nature of the travel over it. Where horse-drawn vehicles predominate, alignment should give way to the lessening of the grade, as horse-drawn vehicles demand easy grade in preference to straight roads. Where motor-vehicular travel predominates, the grade should give way to alignment, inasmuch as the coming of the automobile has brought into highway work the factor of safety of travel, and, with the rapidly increasing use of motor vehicles, places this new responsibility upon the road maker, and the building of highways with long easy curves will tend toward reducing damages to life and property. Roads should be located as direct as is practical and possible, and, under no circumstances, where easy grades can be obtained, should a highway deviate from a direct course, as the direct line or location that enables the engineer to eliminate grades and obtain the required drainage is the most economical.

In determining the amount of drainage to be done in connection with road improvement, it is well to remember that the three principal parts of a road are the surface, the base, and the foundation. The purpose of the surface is to resist the wearing and crushing effects of travel and the disintegrating forces of nature. The purpose of the base is to distribute the loads imposed by traffic over an area of foundation or sub-soil large enough to carry the load. The foundation must carry the load, and the firmer it is the less strength will be required in the base of the paving to distribute the load over it. Almost any dry sub-soil will carry the load if it is distributed to quite a moderate extent. The ability of earth or soil to sustain loads depends largely upon the lack or absence of moisture in it. Most soils can be compacted to form a good, firm foundation as long as they are kept dry, but, upon the appearance of water, they become soft and in a great measure lose their sustaining power.

It would appear, therefore, that the main problem in the construction of a highway is drainage, and without proper drainage no good road can be built; and the importance of so locating roads that the proper drainage is practicable both from a technical and commercial standpoint is manifest. We will discuss briefly some means by which that end may be obtained.

If the ground is level and not subject to flood, there is seldom difficulty in location, but, where the ground is marshy and underlaid with quicksands, it is most difficult and expensive to deal with, and, unless it can be drained at a reasonable cost, should be avoided, even though it involves a considerable detour. A quicksand well drained often makes an excellent foundation for a road; the drainage, however, must be thorough and rapid. The usual difficulty is that ground of this nature is ofttimes nearly level and rapid drainage is out of the question. If the ground is level and subject to flood mainly by backwater, an adequate number of small drains will usually accomplish the desired result, except that it may cost a good deal to raise the grade of the road above flood level, and cases sometimes arise where it is more economical to build a road at a lower level, make it flood-proof and submit to an occasional interruption of traffic, than to make a wide detour or go to the great expense of a fill or viaduct.

If the ground is level and subject to floods running at high velocity—which condition arises quite frequently where roads cross wide level valleys of considerable streams subject to severe floods—great care is necessary in dealing with this kind of a situation. The natural channel of the stream is altogether insufficient to carry the flood water, and, if the bridge crossing the stream is made large enough to carry it, extensive erosion is liable to take place, doing much damage to property and possibly to the highway. If overflow bridges are built, they are very likely to cause formation of side channels and cause great damage to property owners. Usually the best treatment in such a case is to build the bridge large enough to carry the whole stream in flood time, to straighten and widen the channel of the stream as much as possible, remove obstructions, and protect the banks at exposed points. Where this procedure is out of the question by reason of the cost, or for other reasons, it may be necessary to allow the flood water to overflow the road at some points, which must, of course, be made flood-proof. Where such overflow points are provided, they should be made long and shallow to reduce as much as possible the velocity of the current flowing over them; otherwise, adjacent property will suffer unnecessarily. These low places should also be so located as to reduce the actual damage to the minimum, as it is the duty of the public official to protect the just rights of all parties. If the proposed road crosses a narrow valley with a rapid stream, it is almost always best to give the bridge ample waterway and fix the grade above the reach of

high water, taking care, of course, to protect all exposed points against erosion. Where valleys are to be crossed it is always better to cross them where they are narrow and the stream rapid. Such conditions reduce the amount of embankment required and also the span of the bridge, requiring more substantial construction but proving more economical and more enduring in the end.

One other condition met with frequently upon the highways of this commonwealth is that arising from the tendency of one stratum of soil to slide or slip upon another and thus precipitate slips or landslides. These are most difficult and expensive to deal with, and it is seldom, if ever, worth while to attempt to hold such a movement of earth in place by piles or retaining walls. The only sure way and proper treatment, to my knowedge, is the thorough draining or cutting off of the water before it enters the sliding mass. For this purpose, French drains with suitable laterals are generally better than tile drains, inasmuch as a slight movement in the slide will destroy the usefulness of tile drains. The drainage of such a slip must be ample both as regards the sizes and lengths of the drains and the sufficiency of the outlets thereto. This is sometimes a very expensive treatment, but if well done a permanent cure is generally obtained.

The elimination of water from the immediate subgrade, or foundation, of a road is of vital importance and one which it is necessary to thoroughly study and properly arrange for, and is a subject that can not properly and thoroughly be dealt with in a paper of this character. I will not attempt, therefore, to take it up in detail.

In closing, I would say that of alignment, grading and drainage of a road, drainage is by far the most important and should be given first place in the distribution of the funds available for the work, for without proper drainage, any improvement in alignment, grade or character of surface will be absolutely without any permanent result.

PRESIDENT HILL: I see, gentlemen, that you have enjoyed the very excellent paper just read and I am quite sure you will enjoy the comments made thereon by the very distinguished speakers who are to follow. A delegate from Oregon, Mr. S. S. Benson, has had considerable trouble with the local authorities in trying to establish the rule just laid down in the paper, that one foot in twenty is the proper grade. I am going to ask some of the speakers to enlarge on that a little, as they come to speak on the subject later

on. The next speaker will be Mr. R. A. Meeker, State Highway Engineer of New Jersey. (Applause.)

R. A. MEEKER (State Highway Engineer of New Jersey): The paper of Mr. Foster has interested me greatly as it clearly shows that the problem presented to him for solution is similar to that we have before us in New Jersey, namely the improvement of a series of systems of highways that are the outgrowth of our advance in civilization from the pioneer stage. What was good enough for a people who could live comfortably for weeks and even months, though cut off from the town and markets, would not suffice for the present day folk who suffer privation if their supplies are cut off for one day. The division of labor has made us one and all so dependent on our fellows that the means of intercommunication must be the best obtainable. What a good road should be our forefathers clearly and tersely stated in the old statutes granting franchises for turnpikes, to wit, that they must be smooth, hard and convenient for travel at all seasons of the year. The last proviso determines the amount of realignment, grading and drainage to be done in connection with road improvement.

Mr. Foster says: "The determination of the amount of grading to be done in connection with the improvement of any highway will depend largely upon the amount and nature of the travel." If he had said the prospective amount and nature of the travel I would most heartily agree with him, but if this determination is to be based on present travel I must take issue with him. As soon as a road is improved the travel increases so greatly that all former traffic data are of little value; local points, between which the greatest amount of travel existed, no longer are the governing factors in the value of the road, but the improvement must be considered as a whole, one link in a chain of improved highways, and therefore the entire road must be as good as we can make it. The whole system will be no better than its poorest unit, hence the maximum grade must be kept down and, just as important, the minimum grade must be kept up; the first for traction, the second for drainage. Much has been said about the maximum gradient, but very little about the minimum. Five per cent., it is acknowledged, should be the maximum grade for an improved road and one-half per cent. should be the minimum grade if proper drainage is to be had.

Mr. Foster's third axiom is a very true one, yet it is often lost sight of in designing a grade. "If the tendency of the topography is toward a continued elevation the grade line should never be allowed to have a descending grade"; the

amount of energy wasted by the neglect of this axiom is enormous. Mr. Foster says: "Where horse-drawn vehicles predominate, alignment should give way to the lessening of the grade, as horse-drawn vehicles demand easy grades in preference to straight roads; where motor-vehicular travel predominates the grades should give way to alignment." This may be true in Pennsylvania but in New Jersey horse-drawn vehicles never predominate on any improved road, hence the chief modification of our maximum grade is made for the purpose of improving our alignment. For example, our experience is that the safety and convenience of travel are more surely had by building a road with a 6 per cent. grade and a 6 degree curve than by insisting on a 5 per cent. grade, to obtain which without tunnelling will require a 10 degree curve.

One statement made by Mr. Foster cannot be too strongly emphasized, viz.: "The direct line or location that enables the engineer to eliminate grades and obtain the required drainage is the most economical." To obtain this direct line at the least cost requires time for careful study; unfortunately those in authority over him are seldom willing to allow him the needed time and as a result much time and money are wasted after the work is begun. "Make haste slowly," should be the motto in designing all road improvement.

The elimination of water from the immediate subgrade or foundation of a road is of vital importance, says Mr. Foster; to this we add a most hearty "Amen," but would hardly go so far as to say that without proper drainage any improvement in alignment, grade or character of surface will be absolutely without any permanent result. This statement is almost on a par with the one, that road bonds should never be issued for a longer term than ten years, because at the expiration of that period the road will be worn out. The fact is that the surface and in some cases part of the foundation are gone, but the grading, drainage and alignment are still there. Realignment, grading and drainage constitute the permanent improvements of a road, while the surface must be renewed more or less frequently.

PRESIDENT HILL: Gentlemen, the next speaker I hesitate somewhat to introduce, because he is a man who needs no introduction. He was the first president of your association, a man who has borne the heat of the day. He pioneered all over the United States—even came out and campaigned in Washington and Oregon. All the good things out there are due to us; all the bad things are due to him. I take

pleasure in introducing Mr. James H. MacDonald, of Connecticut. (Applause.)

JAMES H. MacDONALD (former State Highway Commissioner of Connecticut): I hardly know, after the two splendid papers which you have listened to, what particular line of this great subject I ought to take up, or what they have left me to take up. I heartily indorse everything that has been said.

The disagreement between the two papers which have been offered is so slight that it is not worth noticing, because I know both states pretty well. I have recently been in Pennsylvania and have had an opportunity to see the difficulties by which the department is surrounded or which it has to meet. I think we are all inclined to differ or agree in regard to a treatment suggested either in this convention or any other convention according as that particular treatment seems or seems not to suit our own particular case.

While going through Pennsylvania, I grew to know the state very well indeed. Brother Foster's modesty perhaps forbade him to state the enormous amount of work that confronts his department and has made him so familiar with this great subject which he has treated so ably. Just think, gentlemen, this great state of Pennsylvania, whose hospitality we are now enjoying, contains a population of 8,000,000 people—one-twelfth of the population of the entire country—and an area of 45,000 square miles, an empire; 90,000 miles of road to take care of, and a pittance, in so far as the money is concerned.

I very much question if we are not laying down a plan of action the premises of which are entirely wrong, in regard to this great question of highway construction. Are we not measuring some other state's peck by our bushel? New England cannot measure what it has to contend with or is confronted by, by other states. I have been in many of the Western States in my work, and I have found that God has been very generous to many of those states in giving to them natural material with which to construct their roads, and a topography that is suitable for almost any kind of treatment. Where we in New England have a kinship with Pennsylvania and with many parts of New Jersey is where hill meets hill and each valley joins another and half the landscape is brother to the other.

This great question of highway improvement is like Colossus lying prone with his head in the lap of the Great Lakes, his left hand reaching out with the fingers playing in the Atlantic, the fingers of his right hand in the Pacific and

his feet resting in the waters of the Gulf. It has got to be a vital question, and brother Powers and other members of this great association that was formed eleven years ago had little conception that in eleven short years this great movement would have grown to the vast proportions that it has.

We are moving too fast, as I said. When the United States government tells us that in this great country, of 2,151,000 miles of road, there has been only 10 per cent. improved—that only 151,000 or perhaps 200,000 miles of those roads are in an improved condition—and that those are principally east of the Mississippi River, it does seem to me in these latter days when nations are born in a day that we should make haste slowly.

I do not hesitate to place my reputation as a road builder, greater or less as it may be, on the statement that there are no permanent roads today in this country and there have not been conceived in the mind of man, nor have there been laid in any state or in any place, upon any street or upon any road, roads that were permanent in their character. And I am very glad to know that the executive committee, in the arrangement of this program, gave such prominence to this great question which we are discussing now. The surface of the road is the top, as has been well said by Brother Meeker. The fundamental principle of all good road building is to begin at the bottom, and that is lost sight of. (Applause.) Brother Meeker spoke about permanency. I quite agree with him; and it is the same with Engineer Foster's paper. We all agree in regard to that matter, and yet, in obedience to some impulse—I don't know and I don't care what the incentive of that impulse is—we are dignifying too much that part that is not permanent and running away from that which is permanent. You never cut a hill in the world to reduce a grade but what that's a permanent improvement to the extent of the money that is expended in the reduction of that grade. You never destroy an old timber culvert or a toy bridge and put in a good, substantial, permanent construction by way of a culvert, but what that's a permanent improvement.

When we read that in one of our states which I will not name, there were 416 lives lost in 11 months and over 2,000 people maimed, it is time that the great question of the sight line and its extension were taken care of. One of the most important things we have in these days of rapid travel is the question of this sight line, and we must not get too far away from it.

The great difficulty with these conventions is this: The

details of that which we offer in a general way are not touched upon enough. You know that in this great state there are, I think, 1,600 townships, in each of which there are three supervisors, making 4,800 men who are directly interested in this great question. They, in turn, select one of their number as a pathmaster. There are 67 great counties here, and while this is one of the largest meetings that I have been privileged to address in the ten years that I have been connected with the association, yet you can see that the difficulty is in reaching the masses of the people so that they can understand. One of the great difficulties with this question and one which the commissioners of the several states have to contend with, is that the people whom they are serving do not know what the department is doing, what the department intends to do, or, in the main, what the department has done.

Now, on this question of grade, drainage and realignment, I should put the question of drainage first—no drainage, no road—and if I were to give a quick definition of how to drain a road, I should say, as the old gentleman said at our convention out at Jamestown at the other end of New York state, "If you want a rooster to crow or a hen to lay or a horse to trot, feed them oats." And if you want to drain a road well, get the water out of the road, get the water off the road and get the water away from the road. Then you have got a well drained road. (Applause.)

There is one thing in the specifications of the state of Connecticut, where I served as commissioner for 18 years, that has never been left out of a specification, that I can ever remember, and that is a rubble drain. And there is another thing that I don't ever remember leaving out, and that is a telford base—a foundation.

In road building, the very best method that I know of is to so build a road that it will have a tight roof and a dry cellar and a foundation and a surface that will shed water.

That rubble drain can be built in almost any place in the country. I remember John Sharp Williams writing that his state was incorrigible, that they could not do anything with it, they had no sand and nothing with which to take care of their drainage or construct their roads, and I sent to him a set of specifications on drainage which had not one line in them that suggested stone, but which provided for taking the trees that they had there and utilizing them from the butts to the topmost branches, taking the logs, piercing, halving, making a core and putting them in the drain, taking the limbs and quartering and using them and then taking the

faggots and binding them together and corduroying the road.

In the system we adopted in our state, it was a very simple matter to get the stone. God has certainly blessed the state of Connecticut with plenty of stone. (Laughter.) I hear so much said about other states and all their advantages in the way of having everything that God ought to, or has, blessed a people with, that I may be pardoned if I just throw in a little suggestion about my state and say that if you go up there, you may trip, if you are not careful, over rose leaves, and your sleep may be disturbed by the song of the nightingale; and if we had a man in our state that was big enough and strong enough and had a flatiron heavy enough and large enough to iron out the wrinkles in that little state, it would cover all Texas. (Applause and laughter.)

In our state, when we started, we had very little money to do with, and I cast about to see what I could do with our first appropriation of $75,000 for an entire state. After looking the field over, with 168 towns to take care of, I decided that the only thing I could do was to take care of the question of drainage and grading. Then, Brother Hill, the silent steed had not come into notice at all; that was eighteen years ago. I remember some twelve years ago speaking in the great city of Boston, at Tremont Temple, and my subject was the country road and the city street, and I remember that the whole burden of my thought was how to build a road that would take care of itself in so far as the mechanician was concerned, or the chemist, to combat the destructive force that was being given to the road by the travel, namely the shoeing of the horse and the shoeing of the wheel, and I called on the engineers to see to it that they constructed a road that would keep pace with these destructive forces and I never mentioned an automobile, and I know had there been very many automobiles in existence at that time, that I would have spoken about them. The other day I read that there were 1,500,000 automobiles manufactured last year, and that, for 83 days, the payroll was over half a million dollars. It used to be thought that the primal question to be taken care of in automobile travel was the question of grade reduction. Now automobiles surmount any grade. But there has come into existence another feature and that is these motor trucks, so that we have got to go back to this question of grading, and unless a grade is reduced to the minimum for taking care of the travel that particular road is called upon to sustain, the road is not right and never will be until it performs its functions in every respect. And in obedience to any cavil, to any

stress, to any influence, even to the daily bread, no engineer can afford to neglect his bounden duty to take care of that particular feature of his work.

In our state, it was natural that we should take up the question of grading. If you will look at our map you will find little rivers and the little streams, I presume to a greater extent than in the majority of states in the union. We found that our people had located their houses on the hills, and while they were a God-fearing people and a Bible reading people, we concluded that, regardless of the promise God had made that the world would never be destroyed by water again, they had put their houses on the hills just the same, as if to say they did not propose to take any chances. (Applause and laughter.) Now, with 90 per cent. of roads unimproved we cannot make parlor floors of all our roads; it would bankrupt any state in the Union. Why, the $50,000,000 asked for by Brother Foster's state was only a bagatelle, and it is a discouragement to keep talking all the time about that great question of the smooth and splendid highways, and it is not always what it seems. I have in my pocket this minute the most negative thing you have ever seen. Up in my state, on one of the roads that has been pronounced a splendid highway, I read in the paper that a man skidded and broke his hip. In the same column, in the same issue of that paper, it was stated that a lady was walking along on an unimproved road and broke her ankle in a rut. (Laughter.) There were the two extremes.

Now what can we do in this great question of properly draining a road? Put in as many culverts as it is necessary to put in. I have never seen, in the whole of my experience, a culvert too large, but I have seen thousands of culverts too small. Put in plenty of culverts and make them too large. I have traveled for miles over the roads abroad and I don't think that I saw, in a day's travel, half a dozen culverts. The country that I went through was flat and the road was raised up and water drained off the road on to the margins. Well, we are doing too much of that here in America. I have been in places in this country where the water had been shed all over the road from the inside gutter to the outside berm. They have also neglected that question of sight line and center and side drainage, and they are still neglecting it.

The question of base is very largely determined by the question of drainage. I have some pictures that I intend to show you to illustrate to what extent Connecticut has gone into this question of grading. In that little state we have a

population of a million and we have the largest mileage of any state in the Union per area, having nearly 13,000 miles of roads, and we are giving the commissioner $6,500,000 this year to spend on roads. Connecticut has always considered this great question of grading and of foundation and this great question of drainage as one of the paramount and most important things we can do.

One of the main features never departed from is the rubble drain. It is an old English rubble drain and I've never known it to fail. It is made by excavating 3 ft. deep in the center or the side of the road, 3 ft. wide at the top, 18 ins. at the base, and laying two side stones 6 ins. high, on top of which is a flat stone, and then on top of that are 18 ins. of stone ranging in size from 3 to 6 ins., and on top of that are 8 ins. of stone ranging in size from 1 in. to 3 ins. On top of the last course put on 2 ins. of inverted sod, straw or hay. The interstices or voids between the stones provide open drainage and there is always a leak-off. I never believed in a blind drain in a road, I always want that road to drain the water out of the road into the drain, and then when it gets into the drain, as our friend Meeker has said, give it a sufficient fall to carry it out of the road and away from the road, and then there is no danger of that road ever settling from frost or heaving, and I have never known that drain when properly built, to ever let down with me or to ever fail of its mission. And any town or any district in this state or in any state can build just such a drain.

The question of grading is not simply the question of cutting down the hill and filling up the hollow, but there is a scientific way of even cutting down the hill and filling up the hollow. I do not mean to go in and load up the load and dump it promiscuously at all kinds of depths in any kind of a way, dropping a load in here and a load in there, but I mean to scientifically distribute that load. And so we have always specified that where the fill exceeds a certain depth, the filling shall be made in courses not to exceed 12 ins., loose measurement, and that each course shall be carried across the entire fill, utilizing the weight of the horse and the weight of the load to compress it. This method shall be followed not only from the base of the bank slope, but to the top of the subgrade upon which the road proper is to be placed. Now that may seem a little matter, but if it is done, you will find that you will never have a settled road. Another part of the work of grading we specify is that in filling out a road on a side hill, we always stagger or roughen

the edge where we put the new material in, so as to get an assimilation between the old and the newly added material. We find that that is a very important matter.

We also find that in grading and making a new shoulder, if we are to have that degree of sustainment necessary to take care of the road after it is constructed, it is necessary for us to shape the subgrade and build the berm or shoulder into the traveled path 8 or 10 ins., and tamp and roll and cut back to the line established for the width of the traveled path before commencing to put in either gravel or metal of any kind.

[Mr. MacDonald at this point showed a number of large photographs illustrating grading and other work done in Connecticut. Several of these showed the work done in the building of the road over Talcott Mountain in the towns of West Hartford and Avon, which was described at length in "Good Roads" for Sept. 2, 1911.]

In 32 of the little towns the first appropriation 18 years ago was only $500, of which the town contributed $125. But the interest has grown so great in my state that the movement is irrepressible and there never has been a time in the history of the state that the money has been denied. If I had any way of emphasizing and forcing into your minds a position to occupy and to never leave, I should say to you at this time, spend the most of your money in grade reduction; in the drainage of your roads, in properly aligning your roads and in making them of proper widths, and the future will take care of the rest. (Applause.)

PRESIDENT HILL: Gentlemen, I am told that the delegate from Ohio appointed on the Committee of Resolutions is not here, and I will appoint Mr. Jesse Taylor as alternate from Ohio; also, the delegate from Wisconsin, Mr. Hotchkiss, not being here, I will appoint Mr. Hirst, of Wisconsin, in his stead.

We will now have the pleasure of hearing from Mr. J. A. Johnston, of Massachusetts. I now have the pleasure of presenting to you Mr. J. A. Johnston. (Applause.)

J. A. JOHNSTON (Division Engineer, Massachusetts Highway Commission): In Massachusetts when we started building state roads motor vehicles were a dream of the future, and with the horse-drawn vehicles a fairly sharp curve was not objectionable. For reasons of economy we therefore followed closely the line of the old road, for changes involved land damage and extra cost. The alignment of a road was changed only to reduce an excessive grade or to cut down the cost of construction. The com-

mission at first adopted 5 per cent. as a maximum grade and the alignment was to be changed where necessary to get this maximum. It was soon decided that this was impracticable and we have built many grades on state highways that are 6½ per cent. though I do not know of anything on strictly state road that exceeds this.

In addition to the regular state roads which are taken over, built and maintained by the state, we have other roads on secondary lines of travel, which though built wholly or in part by money alloted by the highway commission and under the supervision of the engineers of the commission, are maintained by, and remain under the control of, the towns within whose limits they lie. On such roads a somewhat steeper grade is used for a maximum than is the case on the main through highways, or state roads, though there are very few places on these sections of road where the grade exceeds 8 per cent.

To keep within this maximum, we have, of course, been obliged to make many changes in alignment. In some cases the new line not only gives a better grade but is actually shorter than the old.

As I have already said, in the earlier days, grade and cost were about the only things that were considered. As a result we have on our older roads some abrupt curves which were not objectionable for the former horse-drawn traffic, but with the present high-speed motor vehicle, are danger points and will have to be eliminated or at least improved, in the near future. It is, however, a fact, though a paradox, that our most dangerous curves are safest. That is, those places which appear most dangerous are recognized as such and everybody takes extra precaution to avoid accidents at such places. This, however, is tempting fate, for the crop of fools is a large one and we all trot in that class at times, and the fool killer is bound to take his toll. We must, therefore, safeguard our roads by a more careful study of the alignment than has been our practice in the past. For our future work then and for the realignment of our old roads we have three factors: First, the safety of the traveling public which requires that curves be as flat as practicable and that the view be unobstructed so that an approaching vehicle may be seen far enough ahead to avoid a collision; second, grade which may compel a detour—and, as Mr. Foster has so clearly shown us, we are justified in adding considerably to the distance to avoid an excessive climb; third, cost of construction.

While we must, of course, do our work with proper regard

for economy, we must not forget that true economy is seldom obtained by small initial expenditure. I have recently been over a road built in part by Mr. MacDonald and completed by his successor, Mr. Bennett, in Connecticut, where a very large sum of money was expended reducing grade and getting a satisfactory alignment. To those of you who know Mr. MacDonald, I need not say it is an excellent piece of work and a wise expenditure.

The need of proper surface drainage, though presenting many problems, is too apparent to be (and in fact can not be) seriously slighted. The subsurface drainage and foundation are too often neglected. In Massachusetts on our earlier work we placed a great deal of dependence on sub-soil drains, usually built at the edges of the macadam. These drains consisted of a trench 3½ ft. deep with a 5-in. vitrified pipe at the bottom carried to a proper outlet. The trench was then filled with stone. The theory was that this would cut off the water that might enter from the side of the road and, except in unusual conditions, dry out the soil sufficiently to support a macadam road 6 ins. deep. Unfortunately we overlooked the capillary action of the soil, and as many of these roads failed we were obliged to take up the macadam and place additional foundation beneath it. We are now building very few sub-soil drains and those only where there are springs, but are depending more on a heavy base, which is a drain in itself, under the traveled surface. Of course, "enough is as good as a feast" and I could not agree with a newly appointed public official who told me he intended to use telford under every foot of road built under his direction.

The determination of amount and kind of drainage and foundation needed on a road, as in any other structure, is not a task for the novice. We have many miles of highway, built with only 4 ins. of broken stone laid on the natural soil, which have never gone out of shape; but we have many more miles that, though amply strong for the old conditions of light traffic, must be rebuilt with a heavier base to withstand the present heavy hauling. We have all seen deplorable examples of high cost surfacing ruined by lack of proper base. I have been astounded to see paving companies who were trying to demonstrate patented bituminous pavement, laying their product over a base that could not by any possibility hold after the first spring frost. They appeared to forget that their rivals were sure to point out the ruts and hollows as convincing proof of the worthlessness of the surfacing material. I have in mind a certain city where a pav-

ing company laid a large amount of surfacing. It was a part of the agreement that the city should prepare the foundation and the company put on the wearing surface 2 ins. thick. For a base, only about 4 ins. of crushed stone was placed over loam and clay soil. Within two or three years the surface was dangerous to ride over. There was very little disintegration, but the road surface had simply settled into the soft bottom, making ruts and hollows. The whole trouble was due to lack of foundation, but a member of the city government who was mainly responsible for the insufficient base was afterward connected with a rival paving company and did not fail to plan trips for delegations from other cities and towns to see the poor paving laid by the first company.

When commissioners and public officials are trying to make a record for mileage of road constructed, which they call economy, they are too often tempted to neglect the base. If the road is only gravel it can be taken up and additional foundations laid at very little extra cost. Even with broken stone, the added cost is not great and the engineer is justified in taking some chances. Though a macadam road may soften up to a slight degree under frost action, it is easily repaired. Our modern conditions, however, on our main roads demand a surface construction so costly that we cannot afford to have it break and we must safeguard it with more thorough drainage and foundation than we have ever done in the past.

PRESIDENT HILL: Before we close this discussion, I want to call on one or two more men just to say a word, just a moment. I am going to ask Dr. Pratt if he has anything to offer in connection with this matter. Gentlemen, Dr. J. Hyde Pratt. (Applause.)

DR. PRATT: Mr. Chairman, Ladies and Gentlemen: There is one phase of the subject under discussion that I wish to emphasize particularly and to draw an illustration from the work that we are doing in North Carolina, and that is in regard to the location of the road, or, as we have been expressing it here today, the grade of the public road. That, as Mr. MacDonald said, is the only permanent part of any highway that we may build. No matter what the surfacing material may be, we have got to constantly watch and maintain it, but if we once get the road located where it ought to be and get it on the right grade, we have got that portion of the road that is permanent.

Now, there is one phase or part of this question mentioned by Mr. Foster and again by Mr. Johnston, that I would

mention. That is, in certain instances we should give up our grade for alignment. Why? The answer was because of the increased amount of automobile traffic. But in making that statement, only one kind of automobile traffic was mentioned, and that was the pleasure traffic. As we increase our mileage of good roads, automobile trucks are going to constantly increase in numbers and in the numbers that are going to use that mileage. Grades are going to be serious handicaps to the traffic of the automobile truck. Although we manufactured last year a million and a half automobiles, the traffic in horses and mules has not decreased. There will continue to be used on the roads for generations to come just about as many horses and mule-drawn vehicles as are being used today. Now, a stiff grade is a very serious handicap to the transportation of goods in motor trucks and in horse-drawn vehicles. In North Carolina we have considered very seriously that question of grade, and we are trying to make it as near as possible a standard specification for what we call the principal roads of North Carolina that there shall be no grade on them of over 4½ per cent. (Applause.) There are two reasons why we believe that we ought to maintain, as a maximum grade, 4½ per cent.: First, because upon that grade, if it is not too long, you can haul the same load that your horses can haul on the level, and, second, because the minute you begin to increase the grade over 4½ or 5 per cent., you begin to increase very materially the cost of maintenance of the road, unless you happen to be in a country where there is no rain. When you begin to increase the grade over 5 per cent., you at once begin to make a grade the slope of which is of such amount that the water, as it strikes that slope, will come down the center of your road instead of going from the crown to the ditches, because your grade or slope is greater as you go up that hill than it is from the center to the sides. If your slope is more than one in twenty, water is going to follow the steepest slope, which will be down the center of the road, and there is only one alternative, to put in the thank-you-mam, not the old fashioned thank-you-mam, but the V-shaped thank-you-mam which will turn the water off to the ditches as quickly as possible. For those two reasons, we believe in North Carolina that we ought to maintain as the maximum on our main highways, a grade of not over 4½ per cent. We have as hilly a country to travel as any east of the Mississippi River, but we are crossing and recrossing the Blue Ridge and other mountains in North Carolina on maximum grades of 4½ per cent.

PRESIDENT HILL: Now, gentlemen, we come to the last topic of the day, "Factors Governing a Proper Selection of Road or Street Pavement." The paper will be presented by Mr. L. R. Grabill, Superintendent of Suburban Roads, Washington, D. C. Ladies and Gentlemen, I have the pleasure of presenting to you Mr. Grabill.

FACTORS GOVERNING A PROPER SELECTION OF ROAD OR STREET PAVEMENT

By L. R. GRABILL
Superintendent of Suburban Roads, Washington, D. C.

This qestion has been so thoroughly considered by several eminent authorities, notably, among Americans, by Tillson, Byrne, Baker and Frost, that little that is new is left to be said on the subject. The best that can be done is to consider these views from a slightly different angle, so as to show a somewhat different perspective.

The selection of a pavement or road surface is one of the most important of the duties of a highway engineer. The surface of the road or street, equally with the bridge truss or the retaining wall, should be neither over-designed nor under-designed as to the strength required to satisfy the conditions which it will be called upon to meet. In this particular the discrimination and care used must be similar to that of the architect in choosing the type of building suited to the case he has in hand, and to that of the bridge engineer in selecting the kind of bridge he will use. The road builder or the pavement engineer must choose not only the type of surface which will be the easiest over which to pull a load, which will prove durable under the traffic it will carry, and which will be adapted to the numerous local conditions, but he must, if his work is properly done, choose the surface that will produce these results with the minimum final cost, both to the users of the road and to the community which pays for its construction and maintenance.

Nothing could be easier than to select a few types of road suitable to a few locations, and to adhere to these types, regardless of wide variations in the conditions; and this, it is feared, is too often done. It is very much on the safe side to assume that the character of pavement required for the most exacting purpose should be used for very different and lighter requirements; or to assume that the surface which costs the most will necessarily be the best; but it is not always possible to decide with such facility the question of what surface will prove the most satisfactory, under the special conditions involved, for the lowest total expenditure

per ton carried over it. Yet this is the question to be solved in every new construction.

There is frequently the danger, too, that a lack of sufficient funds for the work proposed will cause the effort to be made to cheapen the first cost of construction beyond the limit necessary for durability; and it is not often that the road engineer finds enough funds available to build a better road than he wishes, if indeed he is able to build as well as his judgment dictates. In these cases, however, it is usually possible to limit the area covered, either in length or width, or both, so that a suitable character of surfacing may be employed.

It is assumed in this paper that all of the necessary requirements for the subgrade have been met, such as those that relate to grade, drainage and the preparation of the earth foundation for the pavement. These being the necessary and most permanent parts of the road, should always be well done, in the best and most enduring manner that is practicable with the funds available, even at a sacrifice of the character of the surfacing, which will in time require renewal under any circumstances.

In considering the question from a purely academic standpoint, the availability of the funds necessary for constructing the kind of surface required for any given case may be also assumed, so that the question of cost presents itself only as a factor of the problem, and not as a limiting feature of the selection. This assumption is necessary, because if sufficient money can not be obtained, the question becomes one of the selection not of the proper surface, but of the best one that can be paid for; forming a somewhat different problem, with greater limitations. In fact the entire question may be said to cover two classes of cases, namely, those which are not limited by some special consideration, such as cost, grade, etc., and those which are so limited. The latter class is largely in the majority.

The word pavement is used, in this paper, for any class of hard surfacing of the road or street.

Mr. A. T. Byrne, in his work on "Highway Construction," names the following as the essential qualities of a good pavement:

1.—It should be impervious.

2.—It should afford a good foothold to horses.

3.—It should be hard and durable.

4.—It should be adapted to every grade.

5.—It should suit every class of traffic.

6.—It should offer the minimum resistance to traction

7.—It should be noiseless.

8.—It should yield neither dust nor mud.

9.—It should be easily cleaned.

10.—It should be cheap.

Mr. G. W. Tillson, in the valuable chapter on "The Theory of Pavement," in his book on "Street Pavements and Paving Materials," appears to have originated the method of selection by assigning comparative values to the different qualities of surfaces upon a scale of 100, as follows:

Essential Qualities.	Values.
Cheapness	14
Durability	21
Ease of cleaning	15
Light resistance to traffic	15
Non-slipperiness	7
Ease of maintenance	10
Favorableness to travel	5
Sanitariness	13
	100

Mr. Tillson also gives, in his table No. 51, a summary of the values of the various qualities which he assigns to different pavements, as compared with the full value in the ideal pavement; and by combining the various values of the properties which are demanded to meet particular conditions shows how the selection of a pavement may be made.

In speaking of the values as applied to various pavements, Mr. Tillson says, "It must be understood, of course, that the table is a general one; that much of it is based on the personal judgment of the author; and it will vary in different localities, even if the conclusions are agreed to."

Mr. Ira O. Baker, in "Roads and Pavements," divides the qualities of pavements, and gives the relative values as follows, in percentages of the value of an ideal pavement:

Economic Qualities.	Values.	
Low first cost	15	
Low cost of maintenance	20	
Ease of traction	10	
Good foothold	5	
Ease of cleaning	10	
		60
Sanitary Qualities.		
Noiselessness	15	
Healthfulness	10	
		25
Acceptability.		
Freedom from dust and mud	10	
Comfortable to use	3	
Non-absorbent of heat	2	
		15
		100

Mr. Baker states: "The assignments of these numbers is wholly a matter of judgment, and different individuals will differ greatly as to the relative values to be given to each

COMPARATIVE VALUES OF DIFFERENT PAVEMENTS.

Qualities.	Standard percentage value.	Granite.	Sand-stone.	Asphalt sheet.	Asphalt block.	Brick.	Mac-adam.	Creosot-ed wood.
Cheapness	14	4.0	4.0	6.5	6.5	7.0	14.0	4.5
Durability	20	20.0	17.5	10.0	14.0	12.5	6.0	14.0
Ease of maintenance	10	9.5	10.0	7.5	8.0	8.5	4.5	9.5
Ease of cleaning	14	10.0	11.0	14.0	14.0	12.5	6.0	14.0
Low traction resistance	14	8.5	9.5	14.0	13.5	12.5	8.0	14.0
Non-slipperiness	7	5.5	7.0	3.5	4.5	5.5	6.5	4.0
Favorableness to travel	4	2.5	3.5	4.0	3.5	3.0	3.0	3.5
*Acceptability	4	2.0	2.5	3.5	3.5	2.5	2.5	4.0
Sanitary quality	13	9.0	8.5	13.0	12.0	10.5	4.5	12.5
	100	71.0	73.5	76.0	79.5	74.5	55.0	80.0

*Acceptability includes noise, reflection of light, radiation of heat and emission of odors, etc.

quality * * *. Different values should be assigned to the same quality according to the attendant conditions * * *. The application of these principles is likely to be complicated by the personal interests of the residents or property holders."

An indication of the values of the qualities of different pavements is obtained from the average of the values assigned in ten replies by that number of paving engineers to an inquiry by the United States Forestry Service, which are tabulated, using standard values which are apparently based on Mr. Tillson's but differ slightly. (See table "Comparative Values of Different Pavements.")

The prime factors which should determine the selection of a type of surface, when this selection is not limited by any necessity for giving undue preference to any factor, appear to be as follows:

1.—The volume and nature of the probable traffic over the pavement.

2.—Conditions incident to the location of the pavement, including the character of the adjacent land and improvements; the character of the foundation; the kinds of adjoining pavement; the ruling gradients; the climatic conditions, and especially the availability and cost of different materials at the work.

3.—The characteristics of the surface which will adequately meet physically, hygienically and aesthetically the conditions expressed in the two factors first named. These characteristics are practically those named in the tables cited.

4.—The quotient obtained by dividing the total estimated traffic to be carried per unit of width into the cost per unit of area of the pavement during its probable life, including first cost and interest on the same, special surface treatment for dust suppression or other purposes, and any necessary repair until replacement, but not including the cost of cleaning. For the best pavement this quotient will be the lowest. This ratio may be called the ultimate cost of the pavement per traffic unit carried.

(1) The volume and nature of the traffic—not the present traffic, if the road now exists, but the traffic after the improvement—is the most essential factor. This must necessarily be approximated, and due allowance should be made for increase during the life of the pavement. The effect of traffic upon the pavement should be expressed in units of a known value, to which all classes of traffic can be reduced.

The different effects produced on a surface by different

kinds of traffic are elements which must be considered. A certain tonnage in heavy, slow-moving vehicles with iron tires produces an entirely different effect from that produced by the same tonnage in lighter rapid-moving automobiles with rubber tires; and a still different effect will be produced by the same tonnage in heavier and slower motor trucks. It has been well suggested that a traffic unit should be adopted which could be used to represent as far as possible in the same denomination the amount of wear caused by the passage of one ton over the road in each of the several ways.

The width of the space available for traveled way must be considered in connection with the amount of traffic. One solution of the character of the roadway when pleasure traffic and commercial vehicles use the same highway is to construct a surface adapted to each, separated by a short distance, making a double roadway. This is done to the great advantage of the road users of every class where the travel is sufficiently dense to require it. It is customary, for the reasons indicated, as well as from an aesthetic standpoint, to prohibit heavy traffic on roads built especially for pleasure drives.

This factor of traffic, which is one of the most essential, is sometimes given the least consideration; and we occasionally hear of a county or township bonding itself for a costly form of surface, where a good gravel road would answer the probable demands for some time. On the other hand, in the neighborhood of cities, where the travel is already heavy and sure to increase, roads or pavements are frequently laid which are inadequate for even present conditions.

The nature of the future traffic is quite as important as its volume, although owing to rapid changes in the weight and speed of freight-carrying trucks and the increase of motor-driven vehicles, this is difficult to foresee. An estimate of traffic on a city street made for thirty years hence would probably almost ignore horse-drawn vehicles and would provide for the heaviest class of motor trucks instead.

If the traffic is to be of one class only, such as motor vehicles driven for pleasure with a moderate limit of speed, the problem is much simplified, and it is the writer's experience that no class of traffic is more easily or cheaply provided for. If there is to be a mixed traffic of horse-drawn vehicles, motor trucks, and other automobiles, with a possibility of the steam lorry and train of wagons in the future, this combination will require a very strong and

durable pavement, and first cost should be given little consideration.

There is an approximate limit to the amount of tonnage which can pass over any width-unit of pavement in a given length of time, and any amount of traffic approaching this would demand the very highest type of surface practicable to be constructed. This limit is probably seldom reached for more than a few hours daily on the heaviest traveled streets.

(2) The nature of the surrounding conditions is a potent factor in determining the character of the surface. In a manufacturing or wholesale district where noiselessness is less essential a granite or brick block may well be used on account of its strength or durability, whereas in a residence section the less durable but more quiet asphalt or wood block is better. In a farming or country area a macadam or gravel road harmonizes more perfectly with the surrounding fields and woods.

The value of the adjacent property has a large bearing in the case, for it is the basis of the revenue which usually must be raised to pay for the improvement. A closely built city block can fortunately afford a much higher priced pavement than a less closely built suburban section, on account of its larger taxable value.

The character of the foundation governs the construction in many cases. An especially soft subgrade may require a base of cement concrete; while, with certain types of pavement, upon a hard ground, this might be omitted at a considerable saving of cost. If the problem be that of surfacing an old water bound macadam roadway, it may be solved by using a surface, for instance, of bituminous concrete, placed directly upon the old macadam; whereas if no such foundation existed, an entirely different type of pavement might be required. A rigid surface, such as one of cement, should never be placed where there is danger of settlement.

The ruling gradients of the road must be considered for the reason that some pavements do not afford sufficient foothold upon steep grades, and the climate must be taken into account, since pavements are differently adapted to warm or cold or wet or dry conditions.

The character of adjoining pavements will have weight with the engineer, except in cases where the requirements are very exacting. Again, the practical consideration as to the availability of contractors and suitable construction plants in the vicinity must have weight as entering into the price to be paid.

Among other local conditions, the availability of material, either local or foreign, the use of which latter largely depends upon the cost of transportation, is probably the deciding factor in more cases than any other. A city in an area producing excellent paving brick would be unwise to import granite blocks from a distance at a heavy cost for freight, or even to pay too heavily for the transportation of asphalt; and a Western county could by no means afford to pay the cost of transporting the trap rock used so largely on roads in the East, but must find the solution of its problem in the use of a surface of cement concrete or other material produced near by. The very possibility of the construction of any roadway whatever, in many cases where the funds are limited, is dependent upon making the best possible use of the local materials available.

(3) The characteristics of the surface to be constructed, which must satisfy the requirements of the traffic, the environment, the foundation, the gradients, and the climate, may be divided into three classes, viz.: (a) those which are purely physical; (b) those which are required for health; (c) those meeting requirements of a more or less aesthetic nature.

(a) The physical requirements are as follows: Strength, durability, ease of traction, sufficient roughness when either dry or wet to prevent slipperiness, imperviousness to a greater or less degree, sufficient smoothness to render the surface easily cleaned and to prevent the excessive jarring of vehicles passing over it at high speed, and facility of repair, both as to openings and as to wear of the surface.

(b) The requirements as to health include noiselessness, freedom from dust produced by the wear of the pavement and heat absorbing and heat radiating quality in a minimum amount.

(c) The aesthetic requirements are such as appeal more directly to the senses, and are harmony with surroundings, a pleasing appearance, extreme noiselessness and almost absolute smoothness. These qualities in their highest degree are usually demanded only in connection with streets of the highest class, or with pleasure drives.

Examining these characteristics further, but without going into details as to the qualities of materials, we find as follows:

Imperviousness is a very important feature, both from a sanitary standpoint and as a matter of increasing the durability. No very permeable surface can be considered a good one.

Smoothness is particularly demanded by motor vehicles, especially where speed can be used. Non-slipperiness is produced by small irregularities in the surface. It is necessary for good foothold and also to prevent skidding when the surface is wet.

Facility of repair is essential, and for this reason the pavements should not be constructed of materials and by methods which will be difficult to duplicate after the completion of the original pavement, without at least providing for its repair. Block pavements lend themselves most easily to repair, since they require no large plant for that purpose.

The sanitary requirements are mostly for the benefit of the public living or working on the street and less for the road user. A noisy pavement with much travel seriously affects the nerves of those near it; a dusty pavement permits fine grit to be carried into eyes and lungs and becomes a muddy pavement in wet weather. A heat-absorbing and radiating pavement, such as sheet asphalt, if exposed to the sun, adds much to the temperature of the street and the surroundings in the hot weather, to the discomfort of all in its vicinity.

The aesthetic requirements are such as add a touch of good taste, and perhaps of luxury to the road, and are in increasing demand.

All of these requirements will have somewhat different weights in different cases. Some of them can be omitted in nearly every case and must be omitted often. In view of this it seems best not to assign special values to these requirements, but in each case to give preference to such characteristics as the situation demands, and to use the surface combining these characteristics in the greatest degree.

(4) This combination must produce a pavement, usually, which will give the lowest ratio of total cost to the total traffic units to be carried. The surface thus chosen should be that which is best adapted to the purpose.

In such instances as those in which a high first cost might be prohibitive, the pavement showing the lowest cost-tonnage ratio could not always be selected, and a less costly surface with a higher rate of maintenance would be necessary.

The process of selection usually will be one of elimination, thus: For a certain case of proposed construction several well known classes of pavements, of nearly equal theoretical value, will be considered, say granite block, vitrified brick, wood block and sheet asphalt. If low cost is paramount, this consideration may eliminate the granite block

and the wood block, and if noiselessness, too, is desired the vitrified brick will be eliminated, leaving the sheet asphalt or a similar surface to be adopted. If durability alone is considered the granite block might be chosen, where this material is convenient; whereas if the case demanded noiselessness, smoothness and durability in a high degree, without especial reference to first cost, the wood block would probably receive the verdict.

A resident paving engineer familiar with the local conditions and with pavements in general often need not tabulate or even assemble, otherwise than mentally, the reasons for his choice; and this mental way is very often the method of selection employed, but in such cases the same conditions should and do actually control as would be the case if the situation were being considered for the first time with the utmost pains.

In order to proceed with system in the matter of choice of a new pavement or one in a new location the engineer should have the necessary data as to traffic; as to cost of construction and maintenance of similar pavements in the vicinity and as to the life of such pavements; as to climatic conditions, and, in fact, all available information on the subject. It is unfortunate that the supply of information on these subjects is not what it should be, and this is a defect which every highway engineer can aid in correcting by careful investigation and records in connection with his work. In the absence of the necessary data, the selection is merely an assumption based on judgment and experience.

On the whole, the selection of a pavement, like the tariff, is largely a local question, and in its final aspect, when under practical consideration, presents such a number of features, some of which are predominant at one time and some at other times, that each case must usually be considered alone.

The matter is well summed up in this quotation from Mr. Tillson:

"The official who decides on the material after the most careful investigation will often find that his decision is displeasing to many people * * *. He must make his decision after taking all things into consideration, and stand by it, although it will not always prove satisfactory to all * * *. But if he meet the question successfully and ultimately arrives at the true solution, his satisfaction is as great, perhaps, as in any other branch of his profession."

PRESIDENT HILL: Gentlemen, this discussion will be

opened by Colonel W. D. Sohier, Chairman of the Massachusetts Highway Commission. (Applause.)

WM. D. SOHIER (Chairman, Massachusetts Highway Commission): I am sure we have all been greatly interested in the most excellent paper prepared by Mr. Grabill, Superintendent of Suburban Roads, Washington, D. C.

Before deciding upon any particular surface or pavement for any special road or street, if we are to decide correctly, it is absolutely necessary that we should know exactly what traffic, and particularly the kind of traffic, that the road must carry; not only the present traffic but the future traffic as well.

We found in Massachusetts that in three years, from 1909 to 1912, the traffic on our state highways had often doubled. Its character also had changed. Some roads had more heavy teaming, most of them had less; but motor trucks had replaced the teams, carrying actually more tons per day. Automobile traffic had more than doubled, and what were formerly little country roads, with but twenty to fifty teams a day, now had become interurban and interstate thoroughfares, carrying from 300 to 700 automobiles a day in the season.

Uniform Traffic Statistics Needed.—What we need is some uniform method of taking traffic counts, and some uniform formula that will fairly represent the weight or damage done by the different kinds of traffic, based upon the weight per yard width per year, or per day, so that we can compare results. After a series of years we should then be able to more accurately determine the surface or pavement that would best meet all the necessary requirements. Traffic statistics have been made for many years in certain places in England and on the Continent. The English Road Board has adopted an assumed weight for various vehicles, and many traffic statistics based upon this formula have been made and are now available in various reports. We could well adopt the same formula, based upon American tons, so that we could compare our results with theirs upon a uniform basis.

TABLE I—ENGLISH TRAFFIC FORMULA WEIGHTS.

			Assumed weight of vehicles. (Tons)
Motor Vehicles.	Runabouts		1.48
	Touring cars		2.23
	Trucks		6.25
Horse-drawn Vehicles.	Light vehicles	one horse	.36
	Heavy vehicles		1.12
	Light vehicles	two or more horses	.54
	Heavy vehicles		2.46

The number and class of vehicles having been determined, the traffic per yard width of roadway can be calculated.

TABLE II—GIVING PARTICULARS OF EXPERIENCE OBTAINED IN LIVERPOOL WITH DIFFERENT CLASSES OF SURFACE PAVEMENT

Pavement.	*Tons per yd. width per annum.	Life, years.	Life tonnage per yd. width.	Cost per sq. yd. of surface.	Annual cost including prop'n of capital and maintenance per sq.yd.	Ton miles per yd. width per penny.	Cost per traffic per mile.
6-in. setts	524,000	18	9,432,000	$2.50	$0.170	34.0	.058 cts.
4-in. setts	150,000	50 (Est.)	7,500,000	1.57	.070	24.0	.080
Hard wood	162,000	17	2,754,000	3.87	.250	7.4	.272
Soft wood	204,000	18	3,672,000	2.12	.115	15.5	.128
4-in. pitch macadam	120,000	11	1,320,000	.75	.066	20.6	.096
7-in. water bound macadam...	120,000	1	120,000	.02	.130	7.6	.264
7-in. water bound macadam, tar sprayed	120,000	2	240,000	.25	.112	11.4	.180

NOTE—Tonnages on Road Board basis, except that which, being exceptionally heavy traffic, is based on estimated total actual weights.

*English ton—2,240 pounds.

Wear, Annual Cost of Maintenance, etc.—Mr. Brodie, City Engineer of Liverpool, has made some very accurate studies extending over a period of ten years, covering the weight of traffic per yard width per year, the life of the road, life tonnage per yard width, cost per yard, per ton, etc.

His table, which I give herewith, can be studied with great advantage. (Table II, page 136.)

You will note that the average cost of maintenance, including capital charges, varies from 7 cts. for certain granite setts to 25 cts. per sq. yd. per year for certain wood blocks. (7 cts. for pitch macadam and 4-in. granite setts.) The pitch macadam was practically a trap rock macadam where large stones were used, grouted with a mixture of hot sand and pitch, equal volume, till it flushed, and then smaller stones were rolled in and a surface coat and grits applied on top, and rolled in. One such road is now eleven years old, has not yet been repaired, and has carried a traffic of 120,000 tons per yard width per year. On the average state highway in Massachusetts, with 15 ft. in width of macadam, this would mean 600 to 700 vehicles a day; not of course on a real heavy teaming street, but average traffic.

Cost per Ton per Mile.—These figures do not really, however, tell the story of the actual cost but the cost per ton per mile shows better what duty the road has performed. The wood block carried less than 7½ tons per yard width for each penny expended; the pitch macadam carried over 20 tons, and 6-in. granite setts on a concrete base carried 34 tons. Water bound macadam carried only 7.6 tons, but if it was tar-sprayed it carried nearly 11½ tons for each penny expended.

Another way of stating the same result, is the expenditure for maintenance for each ton transported one mile. This cost varied from under .06 ct. per ton on 6-in. granite setts to about .27 ct. for hard wood block and water bound macadam, while tar-sprayed macadam cost .18 ct., or only two-thirds as much as water bound, and pitch macadam cost only .095 ct., or about one-half of the cost of the tar painted macadam.

Any engineer will find himself amply repaid if he makes a careful study of the traffic statistics and costs which are set forth in many of the papers, both French and English, presented at the International Road Congress, and in the reports of the English Road Board.

Note also that the kind of traffic which has to be carried makes the most difference of all. Every road surface must be strong enough not to be crushed or broken through by

TABLE III—SHOWING WEIGHT OF TRAFFIC IN TONS CARRIED ONE MILE FOR ONE PENNY OF MAINTENANCE COST.

County.	Place.	Weight of Traffic in Tons. Per day.	Per annum.	Average cost per mile per annum.	Weight in tons carried 1 mile for 1 penny.	Cost of maintenance in pence per traffic ton-mile. (penny).	(cents).
Norfolk,	Weybourne	39	14,200	41 £	1.4	.71	1.42
Norfolk,	Edgefield	96	35,000	16 "	9.0	.11	.22
Warwick,	Gaydon Cross Road	185	67,500	86 "	3.2	.31	.62
Warwick,	Wooton Waven	239	87,200	127 "	2.9	.34	.68
Warwick,	The Asps	242	88,300	86 "	4.3	.230	.46
Kent,	*Near Charing	348	126,700	299 "	1.7	.590	1.18
Norfolk,	Framlingham	359	131,000	73 £	7.4	.130	.26
Norfolk,	Lyn-Ely	385	140,500	56 £	10.4	.096	.192
Norfolk,	Diss	390	142,300	55 "	10.7	.093	.186
Warwick,	Haselor Bar	451	164,600	127 "	5.4	.18	.36
Norfolk,	E. Carleton	504	184,000	50 £	15.1	.066	.132
Kent,	Road No. 20	528	192,100	348 "	2.3	.45	.90
Warwick,	Willenhall	609	222,000	269 "	3.4	.29	.58
Warwick,	Elmdon	734	268,000	419 "	2.7	.37	.74
Warwick,	Styvechale	736	268,600	134 "	7.9	.127	.254
Kent,	*Road No. 91	796	289,800	192 "	6.3	.16	.32
E. Sussex,	Roedean	984	359,000	333 "	4.4	.22	.44
Norfolk,	Diss	1,057	386,000	218 "	7.8	.13	.26
Kent,	Sidcup	3,030	1,102,810	2,100 "	2.1	.47	.94
Kent,	*Sidcup	3,030	1,102,810	1,792 "	2.5	.40	.80
Surrey,	Putney	5,694	2,078,300	1,032 "	8.4	.12	.24
Surrey,	*Putney	5,694	2,078,300	604 "	14.3	.07	.14
Average of	Norfolk Roads	9,023	3,300,000	2,298 "	6.0	.16	.32
Average of	Warwickshire Roads	9,777	3,569,000	3,965 "	3.7	.27	.54

*Note—Surface tarred.

COMPARISON WITH TWO MASSACHUSETTS ROADS.

*Beverly	2,898	1,058,430	$3,257	6.50	.155	.37
*Weston	1,920	699,924	1,993	7.02	.14	.28

*Period of 14 years.

any vehicle that goes over it. On the Liverpool paved streets, near the docks, 30 tons on four wheels is not an unusual load. Traction engines on iron tires, weighing 12 tons with their load, are common, as are also two or three trailers, weighing, with load, 8 tons each. Both surface and foundation must be strong enough to bear up every vehicle, without any appreciable rutting or breaking, or the road will be rapidly destroyed.

The cost on different roads in England is given in a table published in connection with the International Road Congress, pamphlet No. 88, report of Messrs. H. T. Wakelam, A. Dryland, Col. R. E. Crompton, C. B., and T. W. A. Hayward. This table of costs is for water bound macadam roads and a very few tar-sprayed roads. (Table III.)

You will note that there are tremendous variations in cost. On some of these roads the maintenance cost is as low as .14 ct. per ton per mile, and on others as high as 1.42 cts. Evidently much further study is necessary to show not only the reason but the remedy for some excessively high costs. I have shown two of our state highways merely for the purposes of comparison, and you will note that the cost of water bound macadam roads is about the average. Where it costs more it becomes evident from looking over the Liverpool statistics that the pavement is entirely inadequate to carry the loads which are going over it.

These statistics, varying as they do, show the absolute necessity for accurate traffic data as a prerequisite to the selection of a road surface or pavement.

In some of the reports of the French engineers, many costs are given that are of much value for traffic here. For instance, the Avenue du Bois de Boulogne, in Paris, was maintained as water bound macadam until 1906. It had to be renewed every three years. The annual cost for maintenance was about 39 cts. per square yard per year. In September, 1906, it was tarred, and the annual cost of maintenance has fallen to about 25 cts. a yard a year, or about two-thirds. It must be remembered that this is a very wide avenue with a tremendous traffic in automobiles and pleasure vehicles, but with little or no teaming.

Asphalts and asphaltic residuums have been but little used in England or France, probably because the tar products are much cheaper, so that it remains for us in this country to keep accurate data, and costs figured on a uniform basis, to determine in each locality what is the best and most economical material that can be used on that particular road to adequately carry the traffic which will pass over it.

PRESIDENT HILL: I am sure you enjoyed what Mr. Sohier said very much. In Kent County, just outside of London, they put down a pavement three years ago and they found that the wear and tear and the thrust were not on the top of the water bound macadam, but on the bottom, and they found, as the railways did with their rails, that where the water bound macadam was worn out, it was worn out in the bottom, all in little round pebbles.

The next discussion will be by Mr. Wm. A. McLean, Commissioner of the Department of Public Roads of Toronto, Ont. Mr. McLean. (Applause.)

W. A. McLEAN (Chief Engineer and Commissioner, Ontario Public Roads and Highways Commission): The paper by Mr. Grabill on "Factors Governing a Proper Selection of Road or Street Pavement" is a most interesting and illuminating contribution. It expresses the complexity of the modern problem which at times confronts road authorities.

Traffic.—Whatever other factor may enter into the problem, roads should be built to suit the traffic, using available materials to the best advantage. To do this requires a thorough knowledge of (1) the traffic, and (2) the material. A paper read before this association last year by Col. Sohier, of Massachusetts, on "Traffic Census" is one of the most noteworthy statements on this phase of the subject yet produced, and is a type of analysis of which we have great need.

Knowledge of Material.—Traffic on the public highway within the past decade has so radically changed that our knowledge of the characteristics of materials in meeting the new requirements is proportionately limited. A paving material should be in general use for at least its estimated lifetime before the facts regarding it are, to a reasonable extent, at our disposal. The mass of facts which we possess regarding any proposed material is an important factor in selection. The elementary materials actually in use in road building are comparatively few—such as broken stone, gravel, sand, clay, asphalt, tar, oils, vitrified brick, creosoted wood, stone setts, Portland cement—but their combinations and variations are almost innumerable. Unless some entirely new material comes above the horizon, the next five years will be a striking era in leading to the more effective use of the materials now available, in confirming or setting aside our opinions of today and in standardizing construction. So far as roads of the open country are concerned—of which I am more especially speaking—there is a vast amount of theory still to be tested.

Division.—A road or pavement may be conveniently divided, for consideration, into four parts: (1) The system of drainage, (2) the earth subgrade, (3) the foundation, and (4) the wearing surface. As a rule, the wearing surface necessary will dictate the character of the substructure. But in other cases one or more necessary or existing features of the substructure will influence our choice of wearing surface.

Foundations.—A secure foundation is an absolute necessity for permanent bituminous coatings. To this end a substantial depth of foundation should be used—a condition with which roads on this continent have not always complied. Very few conditions of heavy or constant traffic can be successfully met with a less foundation than 6 to 9 ins., or a less total depth of stone in the road crust than 10 to 12 ins. The price of good roads in one particular, at least, is a substantial depth of stone. The difficult part of our problem, a financial aspect, is not so much the selection of a wearing surface as our ability to pay for strong foundations. The existing foundation or local materials available for a foundation will frequently dictate what the surface should be.

Heavy motor trucks and busses are placing a great and unexpected strain on road foundations. On main roads leading out of London, England, old 6-in. concrete foundations are being torn up and 9-in. foundations put in their place. This is necessitated by heavy and constant motor-bus and traction engine traffic.

New Bituminous Coatings.—In Great Britain, France and other countries of Europe bituminous treatment has largely become the accepted practice in meeting the requirements of motor traffic in the open country, by carpet coats, by grouting or penetration, and by mixing methods, according to local conditions. It need not be said that asphalt and tar are now, on this continent, being used with marked success—a result that has been reached after many trials and not without tribulation.

That bituminous paving has been markedly successful in England is probably due, to a large extent, to the fact that it has been commonly applied only on old, solid and well settled foundations, in resurfacing their old macadam roads. Many of the failures on this continent, on the other hand, have plainly been due to weak, badly drained foundations. To uneven settlement of new roads under traffic may be attributed much of the failure of bituminous surfaces, rather than to any inherent defect in bitumen itself for road purposes.

Settlement of New Roads.—Roads, as we now build them, are rolled in several layers with a 10 or 12-ton roller, giving a compression of 500 lbs. per in. Traffic follows with tire compression up to 700 and 800 lbs. per sq. in. Under succeeding wet conditions of fall and spring, settlement must inevitably occur, leading to an uneven, wavy surface and consequent decay.

In the speaker's experience a broken stone road commonly does not reach final settlement for two or three years after first construction; but within that period permanent subsidence may be taken for granted. French, German and English road builders laying bituminous surfaces over their old roadbeds are manifestly not dealing with a condition which commonly exists here.

A reasonable course to pursue in many cases would be to build water bound macadam roads on telford or other suitable foundation. The surface could be maintained for two or three years by thin paint coats or oiling. At the end of that period, perfect settlement and stability of the foundation having been attained, a heavy and durable bituminous surface could be applied where traffic demanded it.

Concrete Roads.—The prejudice against concrete roads has, within the past couple of years, been largely broken down, and a good deal has been done to demonstrate their value when built under favorable conditions, indicating more especially a one-course mixture, a high proportion of cement, a clean, tough aggregate, a flat under-surface, joint protection, and good drainage. A number of experimental sections have been built by the Ontario Highway Office, under varying conditions.

So much may be hoped, that there is a temptation to prophesy; but, adhering to a strict basis of proven fact, and in the light of our knowledge of concrete in other structures, it is conservative to say that the next few years should be fruitful in determining the place of this important material in the field of road making—in putting the facts at our disposal to determine when and how it can be used with economy and certainty of results.

PRESIDENT HILL: The next speaker will be Mr. R. B. Gage, Chemist of the Department of Public Roads of New Jersey. I take pleasure in presenting Mr. Gage. (Applause.)

R. B. GAGE (Chemist, New Jersey Department of Public Roads): Mr. Grabill says: "There is, perhaps, no single factor which the engineer has to solve in the construction of any given type of road, that carries greater weight than the selection of a pavement type that will give the maximum

amount of service at the minimum cost." The truth of this statement is almost self-evident. If it were possible to always determine this one point correctly, many of the dismal failures that have occurred in road construction in the last few years would have been avoided.

It is very evident that one given set of factors can not be judicially used to determine this point in all cases. Conditions which a given pavement must meet and successfully resist are constantly changing. A pavement may give good service under one set of conditions and be a failure when more adverse conditions appear. If we assume that the conditions on any given road will remain fairly normal, then a certain set of factors can, no doubt, be successfully used in selecting a type of pavement to meet such conditions. Under such an assumption, the various factors which enter into the selection of a proper road surface have been very plainly, and no doubt, quite correctly, enumerated in Mr. Grabill's paper. Sufficiently uniform conditions may exist on certain city streets to warrant the use of these factors in selecting the pavement type. However, when these factors are used in the selection of a pavement for a country road where the conditions are constantly changing they will often be found to be quite useless for this purpose.

The drainage on a city street is almost ideal compared to that on a country road. The pavement, if a bituminous one, is generally laid on a concrete foundation, is protected by the curbs and the sidewalks which often extend to the curb, and in general little water can get into the sub-base under the curbs. Surplus water is quickly carried off and the streets kept clean both winter and summer. Contrast these conditions with those existing on country roads and we will find there is little, if any, similarity. The pavements on country roads are seldom properly drained and never protected by curbs, are not cleaned in the winter and abundance of water does enter the sub-base from the gutters and banks through the shoulders. It is unfortunate these tables of factors were not compiled by the authorities cited to be applicable to the conditions as they exist on the average country road.

Again, how often is an engineer at liberty to select a pavement by use of the factors given in Mr. Grabill's paper, when such a selection can be made on a purely scientific basis? In one of the tables given showing the relative value of the various factors entering into the construction and maintenance of a pavement, we see the initial cost is given a value of 14 per cent., durability 20 per cent., and maintenance 10 per cent. The real value of these three factors

as they are used today in selecting practically 90 per cent. of the pavements built on country roads, are, in the opinion of the speaker, about as follows: Initial cost 50 per cent., durability 30 per cent., and maintenance 15 per cent. Is it not preferable to determine the type of pavement to be used by the use of the real value of these factors as they are actually being used today than by using them with values based on conditions which are not applicable in the majority of cases?

If bids are asked for several different types of construction, naturally the lowest one is most generally based on an inferior type of construction. This is the chief reason why so many pavements of the penetration type have been constructed in the last few years. If such pavements were selected on account of their durability or low cost of maintenance, we would have few of them today.

There is another factor not mentioned in Mr. Grabill's paper that is of more importance in determining the type of pavement to be constructed than any of the other factors. That is the type of foundation which is to be used. It is certainly false economy to select a standard type of pavement, subject it to adverse conditions and then expect it to give satisfactory service. A pavement may fulfill favorably all the other conditions given in the table cited in Mr. Grabill's paper, yet prove unsatisfactory on account of unfavorable base conditions. This one factor alone is responsible in the majority of cases for more failures in bituminous pavements than all the other causes of failures combined. We are all familiar with the statement: "The pavement should be laid upon a proper foundation;" yet just what constitutes a proper foundation for the different types of pavements is seldom defined. Today, bituminous pavements are being laid on concrete, telford, macadam, gravel and sometimes earth foundations. These bases, as above stated, are seldom, if ever properly drained. Macadam, telford and gravel bases are most generally water-soaked part of the year and often wet and damp during the driest season. In addition, they are subjected to more or less displacement by frosts and under heavy loads often are forced into the sub-base when the frost is leaving the ground. Bases of this type can hardly be considered satisfactory for a bituminous pavement, even if they can be constructed at a very low initial cost. If the cost of constructing a proper, well drained base and a first-class pavement suitable for this type of base is prohibitive, it would be better to reduce the cost of construction by selecting a cheaper type of surface pavement and retain-

ing the originally selected base than to cheapen the cost of construction by reducing the quality of the base.

If we have a stable, well drained base, any kind of a surface pavement can be economically used on the same. The surface pavement can then easily be changed to meet the constantly changing conditions of travel. If the foundation is faulty, to meet such conditions means practically a reconstruction of the entire road. Since the roads that are now being constructed are intended equally as much for the use of the future generations as for the present, it behooves us to construct these bases sufficiently stable and durable so that they will withstand conditions that will be much more severe than those they are now subjected to.

Under such circumstances, it is exceedingly important to first select a proper base and then use the factors given by Mr. Grabill in selecting the surface pavement—if there are sufficient funds remaining and the engineer is not hampered by legal requirements or other influences that render the normal application of these factors impossible. The type of pavement selected must be governed by the character of the base if satisfactory results are to be secured.

This naturally raises the question of just what constitutes a satisfactory base. For a bituminous pavement there is little doubt that concrete is superior to any of the other types, especially if the concrete is first rendered waterproof by squeegeeing it with a light application of tar. The mere fact, however, that a road has a concrete foundation does not necessarily solve the foundation problem even for this type of foundation. The proper construction of a concrete foundation is an exceedingly difficult operation. The various materials should be tested in advance and the proportions of each correctly determined in order to secure the maximum amount of efficiency at the minimum construction cost. The construction of a proper foundation, however, is a subject of vast importance and necessarily needs a great deal of time for its proper consideration, and since it is not directly the subject of this discussion I will not consume any further time on this part of the subject.

PRESIDENT HILL: Now, gentlemen, we will have one more paper and then the session will close. The next speaker will be Mr. D. B. Goodsell, Assistant Engineer of the Bureau of Highways, Borough of Manhattan. I take pleasure in presenting Mr. Goodsell. (Applause.)

D. B. GOODSELL (Assistant Engineer, Bureau of Highways, Borough of Manhattan, New York, N. Y.): Mr. Grabill introduces a somewhat novel idea of ascertaining the value

of a road by dividing the ultimate cost by the unit of traffic. His paper relates to country roads almost exclusively where the selection of pavements is, no doubt, an important matter.

The previous speaker, Mr. W. A. McLean, has stated that the selection of pavements for city streets is limited and the use of the pavements well defined. The speaker can hardly agree to this statement. The engineers of the Borough of Manhattan have found that asphalt pavement has been put where granite is more suitable and vice versa. He believes that traffic and ultimate cost should rule in the selection of city pavements and that, owing to the great value of them, the matter needs to be considered with as much care, at least, as is given to country roads.

It seems to the speaker that the practising city or highway engineer rarely has the opportunity to exercise his decision as to the type of road to be adopted, due largely to two conditions: First, the fact that such authority to decide is very often vested in commissions, commissioners or some such executive; second, that his knowledge of roads or highways is so meager that his sphere of influence is small. And it is on the latter point that I want to say a few words.

If the highway engineer were in the possession of data as to traffic, wear, cost, etc., of the roads under his care, he would, no doubt, influence the selection of this type of road to a greater extent. Such data should, of course, extend over a number of years to be of value so that the rate of increase of traffic and, above all, its kind; the rate of wear under the given traffic, and the ultimate cost may be known. These factors, the speaker feels, are of the highest importance and are today only beginning to be appreciated.

Mr. Grabill has referred to the fact that property of low assessed value cannot afford as expensive a pavement as that of high value. It seems, that where a good and costly road is needed this objection might be easily met by deferred or installment payments, such as are usual in the northwestern states, where this condition has actually occurred.

The speaker believes that the two controlling factors, outside of cost, which have exerted the widest influence, where an academic view has been taken, are traffic and grade; that many of the factors alluded to in the paper are dependent on these two. Take, for instance, strength, durability, ease of traction, roughness, slipperiness, ease of cleaning, dust, etc.

A most important factor, the annual cost of maintenance

per square yard per year, is rarely accorded the consideration it deserves. Very little general data is obtainable as to this, and few city engineers have taken the trouble to ascertain at what time in the life of their pavements it is economical to renew or repave.

The writer desires to direct attention to the excellent articles by Mr. G. H. Norton, Deputy Engineer, Commissioner of the Department of Public Works of Buffalo, N. Y., in "Engineering News" of Sept. 26, 1912, and by Mr. J. E. Barlow, Engineer, City of Cincinnati, in the "Municipal Journal" of Jan. 18, 1912. Both of these seem, to the speaker, to be commendable attempts to solve the problem of what the cost of maintenance is for each succeeding year of life of asphalt pavement and, in consequence, the ultimate cost, a factor of prime importance.

The average cost of maintaining granite pavement, wood pavement and other costly pavements is practically unknown. Of wood pavement the speaker has recently collected the following:

In Germany (94 towns) a cost of 22.5 cts. per sq. yd. per year is indicated; in Paris, 20 cts.; Minneapolis, 0.1 ct.; St. Louis, 0.2 ct.; Brooklyn, 0.05 ct.; Manhattan, 6 cts.

The low cost in the American cities is probably accounted for by the newness of the pavements and the fact that no attempt has been made to record the conditions leading to them, age of pavement, etc.

Brooklyn, Buffalo, Manhattan, Syracuse and Washington are some of the eastern cities which have recorded the yearly maintenance costs of sheet asphalt in such form that a systematic analysis of the repair increase due to age may be made.

In this connection the writer would point out the desirability of recording percentages of area restored each year for intercity comparison rather than the cost which introduces an uncertainty; and also that there is a limit to the amount of repairing which can be done on an asphalt street beyond which its condition begins to be uniform or improve so that a curve of rising maintenance costs becomes horizontal.

In investigating the repair (annual cost of maintenance) curve of the asphalt pavements of the borough of Manhattan, New York City, the speaker found that when the cost reached 17.7 cts. for heavy traffic, 14 cts. for medium traffic and 8.9 cts. for light traffic, these costs remained thereafter uniform, probably due to the improved condition of the wearing surface.

The speaker believes that the prime factors governing the selection of a pavement may be reduced to three: Cost, grade and traffic. By cost is meant ultimate cost, and no engineer is in a position to state what this may be on either a city street or country road without traffic statistics, measurements of wear and cost data of maintenance —three things which, it is safe to say, are seldom given attention by the average city or highway engineer.

A. C. Mountain, City Engineer of Melbourne, Australia, recites the story of an American asphalt agent in Sydney who cited so graphically the case of the then poor wood pavements in Memphis, Tenn., that a board of medical men, chemists and experts appointed to report on the suitability of Australian hard wood on concrete as a paving material reported against its use in that city. Had he been required to answer with data, some of the questions to which allusion has been made, a fairer conclusion might have been reached.

PRESIDENT HILL: Gentlemen, we will now adjourn until ten o'clock tomorrow morning. We only have two hours in the morning, so I hope you will be here promptly on time.

Theater Party Given by Citizens of Philadelphia

On the evening of Wednesday, December 10, A. R. B. A. members and exhibitors were entertained by the citizens of Philadelphia at a theater party. The entire orchestra at the Forrest Theater on Broad and Sansom Streets was reserved for a performance of "The Sunshine Girl," with Julia Sanderson playing the leading part. A large number of association members and exhibitors attended.

FIFTH SESSION

Thursday Forenoon, December 11

CHAIRMAN HAROLD PARKER (First Vice President, American Road Builders' Association): Gentlemen, please come to order.

I would like to announce that in the appointment of the committee on resolutions, the state of Maryland was left out, and to correct that error, I announce that Major W. W. Crosby has been selected for the state of Maryland.

President Hill has requested me to preside at the meeting today, on account of the fact that the labors that he performed the last two days have been too much for him;

therefore, I have taken his place and I hope you will follow as carefully and with as little delay as possible the steps taken today, because at half-past one you are supposed to go off in automobiles to take account of the things that are done in the city of Philadelphia, and that means, with the long list of subjects for today, that there can be very little intermission between any two of the papers which are to be read here, and that there is very little time for any discussion. Therefore, without further preliminary statement, I will call upon Mr. George L. Watson, the General Superintendent of the Continental Public Works Co. of New York, to read the paper of Mr. Linn White, Chief Engineer of the Board of South Park Commissioners of Chicago.

BITUMINOUS MACADAM AND BITUMINOUS CONCRETE

By LINN WHITE
Chief Engineer, South Park Commissioners, Chicago, Ill.

In any consideration of this dual subject there are two aspects from which it may be viewed—the technical and the practical. From the technical aspect the distinction between the two is defined by the commonly accepted significance of the words concrete and macadam. The definition of the two pavements was attempted by the Sub-Committee on Bituminous Paving Nomenclature reporting to the Grand Rapids convention of the American Society of Municipal Improvements in 1911. This report was not a unanimous report of the committee, as all the members were not present at the convention. It was adopted by the convention, however, with very few or no objections. A quotation from the report is as follows:

"Bituminous concrete is a pavement consisting of a combination of broken stone and sand, or fine mineral matter, cemented together with a bituminous cement, and which has all its ingredients mechanically mixed before being laid. To be termed a bituminous concrete it must partake of the well known characteristics of concrete; that is, there must be stone enough in its composition to form an important part thereof and add to its strength and durability; also there must be enough of the mortar constituent, that is, the sand and bituminous cement, to properly support and bond together the largest particles. It is normally a one-layer pavement, all parts of it having equal stability, due both to the structure of stone and the bond of the bituminous cement, and depending on the base for vertical support only. It may or may not be finished with a skim coat and top dressing of sand or stone chips. It is adapted to be

laid on either a hydraulic concrete or macadam base which may or may not have a light coat of bitumen to increase the adhesion.

"In the paving mixture, gravel may wholly or in part be substituted for crushed stone, and fine crushed stone for sand. Mineral dust also may be added to increase the density and stability of the mixture.

"Bituminous macadam is a pavement consisting principally of crushed stone which retains its integrity of structure mainly by the mutual support of the various particles of stone, aided by the slight bonding value of the fine mineral matter in its composition, and protected from surface disturbances by an upper bonding layer of bituminous material. It is a one-layer pavement and there is no definite distinction to be made between the wearing surface and the base, as in their nature they must be knit together in one structure. Practically all the horizontal stability, as well as vertical support, is from the macadam base. The pavement may be produced by adding the bituminous top to the macadam base by either the penetration method or the mixing method. In the former the bitumen is applied in a liquid state and a top dressing of stone or sand is spread over the surface and thoroughly rolled. In the latter the bitumen is mixed with the mineral, consisting of comparatively fine stone or sand, or a mixture of both, and forced into the macadam body of the pavement by rolling. In either case, whether the penetration or mixing method is followed, the macadam base must be specially prepared, with voids in the upper portion into which the bitumen or bituminous mixture penetrates, leaving a coating of the desired thickness over the surface."

The essentials of this definition of bituminous concrete are that "there must be stone enough in its composition to form an important part thereof and add to its strength and durability" and the mortar constituent or matrix must "properly support and bond together the larger particles." There is in this no requirement that the stone must be in a definite or minimum quantity, that it must be of a definite size or that it must be of varying or graded sizes. From a practical standpoint the stone in the paving mixture may add to the strength and durability in several different ways. It may, by presenting enlarged mineral surfaces to the traffic, increase the resistance to surface wear and increase the tractive power of horses or motor-driven wheels, the increased size of the particles may offer a greater resistance to lateral displacement and may lessen the necessary

amount of bitumen, all without carefully grading the aggregate as insisted on sometimes. The second essential quoted above, referring to the mortar or matrix, requires that there shall be enough mortar in the composition and enough bitumen in the mortar to properly bond the whole mass and (it should be added) to waterproof it. It is not practical or economical to bond and waterproof the stone by the use of bitumen alone, therefore sand and mineral dust are used to stiffen and strengthen the mortar and at the same time lessen the necessary amount of bitumen, which is the most costly ingredient in the pavement. It is found that the best and most waterproof mortar is made with graded particles ranging from the coarsest grains of sand down to an impalpable powder. This is the most scientific method of waterproofing mortars, as practiced by up-to-date concrete engineers, and at the same time produces the stiffest and most stable of mortars least affected by changes in temperature, which is an essential in a successful pavement.

If these premises are correct the obvious conclusion is that the successful and correct method of making a bituminous concrete pavement is to prepare a well filled and waterproof mortar with which shall be combined a reasonable and proper amount of broken stone which may be of one size only or of graded sizes. Examples may be given of paving mixtures where success or failure evidently hinges on the quality of the mortar and not on the size or grading of the stone. Also examples can be given where the stone was well graded and the mortar not made according to sound principles, resulting in inevitable failure. The following analyses of samples taken from pavements as laid are illustrative of the above statements:

	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.	No. 6.
Bitumen	5.6%	7.4%	8.4%	7.2%	5.5%	7.3%
Pass 200 mesh	3.5	5.3	1.9	1.5	8.8	9.5
" 80 "	12.0	3.1	2.6	2.5	4.6	8.1
" 40 "	13.7	10.3	22.3	23.9	19.3	13.7
" 10 "	16.3	19.3	9.1	9.0	3.2	6.1
" 8 "	2.7	3.3	1.9	1.3	0.6	0.9
" 4 "	12.9	12.3	9.2	7.8	7.0	15.0
" 2 "	19.0	19.2	31.3	28.0	51.0	39.4
Retained	14.3	19.8	13.3	18.8	...	...

Nos. 1 and 2 were from the same job, were under quite heavy traffic both teaming and automobile, and No. 2 stood up much better than No. 1.

Nos. 3 and 4 were from another street also under quite heavy mixed traffic and both of them showed very poor results, disintegrating in cold, wet weather, although an examination of the bitumen itself showed no deterioration. The failure was evidently because of improper filling and

waterproofing due to lack of dust and fine mineral in the mixture.

Nos. 5 and 6 are from newer pavements which have not been under traffic long enough to be thoroughly tested out, but in the author's judgment show good grading in the fine-mesh material and should give a good account of themselves under traffic.

Note in Nos. 5 and 6 the grading (or lack of grading) in the stone, that is, in the material coarser than 10 mesh. Nearly all of it is ½-in. stone with but little ¼-in. and scarcely any ⅛-in.

Bituminous macadam is generally produced by the penetration method and involves the principle of forcing the bituminous binder into the stone after it is in place. This may be accomplished by various methods, differing more or less from each other, but all dependent on the principle stated above. The bitumen may even be mixed with sand or other fine material and forced into the stone, though in practice not very often done. By properly preparing macadam surfaces with a coarse, open layer of stone on top, covered with mixed bitumen and sand, well rolled into the interstices of the stone, a very economical and serviceable pavement may be made. Such a pavement cannot be classed as a bituminous concrete, and cannot rank with well made bituminous concretes in serviceability. It can only be called a bituminous macadam. In the author's experience decidedly the best results have been obtained in bituminous concrete pavements on macadam base by paying particular attention to the preparation of the base with a coarse, open layer of stone on top into which the paving mixture is forced as plaster is forced into the interstices of laths on a wall. No specifications for bituminous concrete should omit this feature, in fact in the author's opinion, it is fully as important as the proper filling and waterproofing of the mortar. This statement is made particularly with reference to macadam base, though, in perhaps a lesser degree, it applies to concrete base. There is no defensible reason for flushing a concrete base up smooth, and then for the sake of restoring the lateral stability thus lost, adding a binder course between the base and top of any kind of bituminous pavement. Give the base a coarse, strong surface and you have a stability attained in no other way.

Bituminous concrete and bituminous macadam find their greatest field of usefulness not in competition with the expensive block pavements on heavy traffic streets, but on highways and boulevards, in residence and suburban dis-

tricts. They come into competition with sheet asphalt, brick and concrete pavements. They are most adaptable to use on macadam, either new or old. There are cases of a bituminous macadam wearing surface on a concrete base, but such cases are anomalous and such construction is illogical.

In addition to certain important features referred to earlier in this paper, the following statements are offered as practically axiomatic:

1. Bituminous concrete and bituminous macadam of equal thickness require the same amount of bitumen per square yard.
2. Considering the total thickness of wearing surface and base, and disregarding first cost of plant, the only difference in cost between bituminous concrete and bituminous macadam is the difference in labor, amounting to generally less than 10 cts. per sq. yd.
3. Old macadam is a difficult and uncertain proposition to penetrate with poured bitumen on account of dirty stone, and generally requires a new top layer of stone to produce a successful bituminous macadam, but if of substantial thickness may be utilized as a base for bituminous concrete.
4. The mixing and laying of bituminous concrete may be carried on during damp and cool weather when it would not be practical to construct bituminous macadam.
5. Bituminous concrete is of even thickness and even composition and consequently wears more evenly than bituminous macadam, no matter how well made, and costs less for repair and maintenance.

In all these respects the advantage of comparison is in favor of bituminous concrete, except in the one of first cost.

CHAIRMAN PARKER: Gentlemen, the first person who is to discuss this paper is Professor Arthur H. Blanchard, of Columbia University.

ARTHUR H. BLANCHARD (Professor of Highway Engineering, Columbia University): The speaker will confine his remarks to a discussion of the points covered in Mr. White's interesting paper. As one of the dissenting members of the committee of the American Society of Municipal Improvements, the speaker appreciates the courtesy of Mr. White in publicly stating that the quoted definitions relative to bituminous pavements were not supported by all the members of that committee. It appears to the speaker that Mr. White omits, in his definitions of bituminous concrete and bituminous macadam, certain types of construction. Under

bituminous concrete, he refers only to pavements constructed by the mixing method in which the mineral aggregate consists of broken stone and sand. He covers by his definition of bituminous macadam, two types of construction: First, the type usually designated as a bituminous pavement constructed by the penetration method, that is, one in which a bituminous material is applied over a course of broken stone laid in place; and, second, a type of pavement little used, of which the mixing of the bituminous material with stone chips or sand and the application of this mixture on a loose layer of broken stone constitutes the characteristic feature. It is thus seen that the type of bituminous pavement constructed with a wearing course consisting of a mineral aggregate of one size crusher run stone and bituminous cement is not covered by Mr. White's definitions.

The special committee of the American Society of Civil Engineers on bituminous materials for road construction has proposed a comprehensive definition of bituminous concrete which definitely differentiates bituminous pavements built by mixing methods and those built by penetration methods. The definition referred to is as follows:

"Bituminous concrete pavements are those composed of stone, gravel, sand, shell, or slag or combinations thereof and bituminous materials incorporated together by mixing methods."

As will be seen from the following quotation from the 1913 report, the Association for Standardizing Paving Specifications recognizes the definite types to be covered by the term bituminous macadam:

"If the stone is spread in place and the bituminous cement or binder applied afterward, the resulting product is bituminous macadam."

The three general classes of bituminous concrete pavements will be considered in the following discussion.

It is self-evident that the simplest type is one having a mineral aggregate composed of one size crusher run stone; that is, similar to the product, in the usual type of portable plant, which passes over one screen and through the larger holes of the adjacent screen. This broken stone, in certain cases, may be uniform in size, but usually such is not the case. In the speaker's opinion, an essential element in the construction of this type of bituminous concrete pavement consists in using a one size crusher run stone which will have a considerable range in its sizes. As an illustration will be cited a mechanical analysis of a product which was obtained

from a crushing plant where the broken stone passed over a ½-in. screen and through a 1¼-in. screen.

Passing	⅛ inch screen	1.2%
"	¼ " "	4.2 "
"	½ " "	34.7 "
"	¾ " "	40.6 "
"	1 " "	17.3 "
"	1¼ " "	2.0 "

It is apparent that the above product would not be referred to as composed of uniform sized stone. This type of bituminous concrete pavement, however, has been constructed for many years by using broken stone of uniform size in successive layers, the size decreasing from bottom to top. As an illustration will be cited the practice of one large construction company which builds this type of pavement. The first, or bottom course, of bituminous coated metal ranges from 1¼ ins. to 2½ ins.; the second course, from ½ in. to 1¼ in.; and the third course, from ¼ in. to ½ in. The pavement is finished with a dressing of uncoated chips.

The second type of bituminous concrete pavement has been fully covered by Mr. White; that is, the type in which a mixture of broken stone and sand is used as the mineral aggregate. This type of aggregate is usually covered in specifications by stating that so many parts of broken stone and so many parts of sand shall be used. The broken stone called for is usually one size crusher run. In many cases a specific grading of sand is mentioned.

In the third type of bituminous concrete pavement the composition of the mineral aggregate is more or less definitely covered in the specifications. As an example may be cited the following method of covering the composition of the mineral aggregate of the Warrenite pavement, which was employed by William H. Connell, Chief of the Philadelphia Bureau of Highways and Street Cleaning, in drafting the specifications for the city of Philadelphia.

Material passing 1¼-in. screen and retained on No. 2 sieve, 40 to 60 per cent. Material passing No. 2 sieve and retained on No. 4 sieve, 10 to 20 per cent. Material passing No. 4 sieve and retained on No. 10 sieve, 10 to 5 per cent. Material passing No. 10 sieve and retained on No. 30 sieve, 10 to 5 per cent. Material passing No. 80 sieve at least 25 per cent. of which will pass a No. 200 sieve, 10 to 5 per cent. The balance, to pass No. 30 sieve and be retained on No. 80 sieve.

As another illustration might be cited the well known Topeka specification, which covers a definite grading of a mixture of broken stone and sand. The Topeka grading is as follows:

Bitumen			from 7 to 11%
Mineral Aggregate:			
Passing 200 mesh screen			" 5 " 11 "
"	40 " "		" 18 " 30 "
"	10 " "		" 25 " 55 "
"	4 " "		" 8 " 22 "
"	2 " "		less than 10 "

In the construction of all types of bituminous concrete pavements, in addition to the requirements covering the properties of the bituminous cement and the quality and character of the mineral aggregate, certain essential features should be given careful consideration.

If a considerable yardage of bituminous concrete pavement is to be laid, the speaker believes in using a plant so designed that the mineral aggregate is passed through revolving driers before it comes to the mixer.

The specifications covering plant operation and the construction of the bituminous concrete wearing surface should include strict requirements relative to the allowable maximum and minimum temperatures while heating the bituminous cement and the mineral aggregate and during the mixing of the two ingredients, and the minimum temperature at which the mixture is allowed to be delivered at the mixing plant and deposited on the highway. The maximum and minimum temperatures will depend upon the type and grade of bituminous material, the character of the mineral aggregate, and climatic and other local conditions.

In the construction of bituminous concrete pavements the tandem roller has been found, in the speaker's experience, to be preferable to the three-wheel roller. It is advisable to specify both the type and the weight of roller which will be required for the construction of the wearing course. For the compression of the first type of bituminous concrete mentioned above, the speaker has found that a tandem roller weighing between ten and twelve tons gives satisfactory results.

In certain types of bituminous concrete pavements a seal coat of bituminous cement is employed. In such cases the details of its application, such as the amount to be used and the method employed, should be covered in the specifications. Whatever method or machine is used in the distribution of the seal coat, it is believed that the application should be immediately followed by squeegeeing in order to secure uniform distribution.

Many essential details covering the construction of bituminous concrete pavements will be found by reference to the specifications adopted by the Association for Standardizing Paving Specifications and those used by certain public service

bodies, such as the Board of Water Supply of the city of New York, and the highway departments of certain municipalities as, for example, those of Philadelphia and Spokane.

CHAIRMAN PARKER: Mr. Pillsbury, have you got something to say on this subject?

F. C. PILLSBURY (Division Engineer, Massachusetts Highway Commission): I want to thank the Chairman and the association for the opportunity to take part in the discussion. I have listened with a great deal of pleasure to Professor Blanchard and the reading of Mr. White's paper. I know you have got a long and varied program, and I feel that we will gain a great deal more by listening to the others on the program than by listening to me.

[The following discussion prepared by Mr. Pillsbury was not read, but was transmitted to the association and made a part of the official records.]

F. C. PILLSBURY (Division Engineer, Massachusetts Highway Commission): I have very little to add to the able paper of Mr. White and the discussion of Prof. Blanchard, but I would call attention to one thing which I think has not been made clear, that is, the comparison between bituminous macadam and bituminous concrete.

Bituminous concrete refers to the so-called "mixing methods," and bituminous macadam refers, in this discussion and comparison, to a bituminous surface constructed by the so-called penetration methods. Mr. White, in his reference to bituminous macadam, refers to penetration into broken stone with a mixture of bitumen and sand, but I would take up the discussion from a somewhat broader standpoint, and refer to bituminous macadam as being constructed by any penetration method.

I believe that when modern pressure machinery and good bitumens are used, bituminous macadam may be constructed by the penetration method which will compare favorably with some of the bituminous concretes constructed by "mixing methods." I call attention to the fact that a great deal of money has been expended for bituminous concrete in following certain theories, with the result that after one to three or four years, the surfaces have either gone to pieces or have become so bad that it has been necessary to rebuild or resurface them; or, in cases where it has become apparent that the surface was soon going, sealing coats or surface applications have been necessary. It seems to me that it is folly to build a bituminous concrete that in a short time will go to pieces, when a bituminous macadam road can be built at a lower cost that lasts as long as bituminous concrete; or at the same cost, that will last longer.

When all the aggregates are carefully and properly graded, a bituminous concrete can be laid that will be more permanent and will withstand heavier traffic than will any surface penetration method, and when the workmanship is what it should be, and a first-class bituminous material is used, the highest perfection in a bituminous surface will be reached, and this should be equal, if not superior, to certain types of block pavement. So, if a bituminous concrete is to be successful, it is necessary to have a well graded mixture; excellent materials and excellent workmanship. There is no question about this, and it seems almost foolish to keep stating it, but still, at many places, bituminous concrete is laid with (notice the comparison), a mixture not at all graded, no intelligent discrimination in the choice of materials, and unskilled labor.

It must be allowed that bituminous concrete depends mainly for its stability upon the adhesive or cementitious quality of the bitumen, for even if the mineral aggregate is properly graded, unless there is bitumen present, the mineral does not, when exposed to traffic, become anything else than a loose moving mass without any stability in itself. Unquestionably, the best or strongest cement will give the best results, hence the greatest factor affecting permanency of the surface is the bitumen. On the other hand, if a penetration road is so constructed that the stones of the mineral aggregate form in themselves a well-bound surface, even after the bitumen has lost its cementing qualities, such a road is more permanent than an imperfect bituminous concrete, and when some good bitumen is properly used, the results will be well worth the additional expense of the higher cost of better bitumen. If I am correct, the life of the bituminous concrete is measured principally by the bitumen, whereas the life of the bituminous macadam, properly constructed, depends to a great degree upon the stability of the mineral itself, as well as the cementing quality of the bitumen, so that when the bitumen is gone, the stones will still bind themselves together, to some extent.

I would suggest as a very good type of construction for roads which are not subject to excessively heavy teaming, and yet could stand any number of motor vehicles and fairly heavily loaded horse-drawn vehicles, that described in the following specifications:

SPECIFICATIONS FOR BITUMINOUS MACADAM, PENETRATION METHOD.

Broken stone consisting of trap rock or rock, which, in the opinion of the engineer, is equal to trap rock, shall be spread and rolled on the roadbed prepared as follows:

The width of the broken stone shall be —— feet.

The lower course shall consist of stones that will not be more than 2½ nor less than 1½ ins. in their longest dimensions, and shall be —— inches deep at the center and —— deep at the sides after rolling. (This depth of stone in the base depends to some degree upon the weight of the traffic and may be increased to withstand a heavier traffic. Of course, foundations should always be adequate and drainage perfect.)

The lower course shall be shaped to a true section conforming to the proposed cross section of the highway and thoroughly rolled.

Any depressions and irregularities which may occur shall be filled with smaller stones as directed by the engineer, and again rolled until the surface is true and unyielding. The interstices in this course shall then be filled with clean, sharp sand or screened gravel or stone dust, and after being rolled dry in a thorough manner the sand or screened gravel shall be just below the top of the broken stone as directed by the engineer and no sand or gravel shall be left on top of the stones.

Upon the lower course shall be spread the upper course of stone which shall consist of stones varying in size from 1½ ins. to 2½ ins. in their longest dimensions, and shall be 2 ins. in thickness after rolling with a steam roller, evened up with material of the same size and quality as has been used in that particular course, to the satisfaction of the engineer. Upon the upper course of stone prepared as described, bitumen shall be uniformly applied with a pressure machine at the rate of 1¾ gals. per sq. yd. of surface and immediately covered with a thin spreading of pea stone or clean broken stone chips, just sufficient in quantity to permit the roller to pass over the surface without adhering to the bitumen. The surface shall then be thoroughly rolled. A second application of bitumen shall then be made, in the same manner as the first application, at the rate of ½ gal. per sq. yd., and immediately covered with pea stone in sufficient quantity and satisfactory to the engineer, and then thoroughly rolled. In distributing the bitumen no over-lapping shall be allowed.

The contractor shall sprinkle the road with water when and as directed by the engineer.

All depressions in any course shall be filled with the same material used in that particular course and shall be rolled until a smooth, true and unyielding surface is obtained.

The bituminous binder shall consist of .... and when applied to the road surface it shall have a temperature approximately 300° F.

If, at any time before the acceptance of the work any soft or imperfect places or spots shall develop in the surface, all such spots shall be removed and replaced with new material and then rolled until joints or edges at which the new work connects with the old become invisible. All such removal and replacement of unsatisfactory surfacing shall be done at the expense of the Contractor.

No bituminous work shall be done during rainy weather nor when weather conditions as to temperature or otherwise are, in the opinion of the Engineer, unsatisfactory for obtaining good results.

In the above specifications there are three chief requirements which I desire to call attention to: Size of the mineral

aggregate, quality of the bitumen, and method of its application.

As one may judge from my remarks, I do not agree with Mr. White in his statement that bituminous macadam, no matter how well made, costs more for repair and maintenance than bituminous concrete. I would qualify this by remarking that the particular characteristics of each should be taken into consideration before stating such a comparison.

CHAIRMAN PARKER: Thank you, Mr. Pillsbury. I don't think there is anybody who knows more on the subject than you do, therefore I think we would get a great deal of valuable information, but I did not prepare this schedule and our time is limited and I have got to cut short.

I don't suppose there is anybody else who wants to say anything on this particular matter that has been so thoroughly covered by these gentlemen who have already spoken. I will take it for granted that you don't want to say anything. (Laughter.)

The next paper, "Earth Roads," is by Mr. E. A. Kingsley, State Highway Engineer of the Arkansas State Highway Commission.

EARTH ROADS

By E. A. KINGSLEY
State Highway Engineer of Arkansas

In the more thickly settled sections of the country earth roads are being rapidly replaced by those having hard wearing surfaces. Increased vehicle traffic and the rapid advance of the automobile have forced many communities to build roads to stand the additional wear and tear required of them. But the old time earth road is by a large majority the big end of the present day road problem and it will continue to be for many generations to come. The importance of matters pertaining to the construction and maintenance of earth roads may be realized when we consider that fully 90 per cent. of the more than two million miles of road in the United States are earth roads.

In recent years it has become popular to neglect entirely and to decry the earth road. In fact there are some engineers who will go so far as to say that even a first-class water bound macadam road is a relic of the dark ages and should be frowned upon. Only recently a convention of prominent engineers refused to recognize water bound macadam as a proper road surface. The writer will not acknowledge that either earth roads or macadam roads can be relegated to the past. Gradually the main roads, as traffic

demands, will be improved with a more permanent surface. But there will always be many roads, and for many years, many main roads, which will remain as earth roads. Rather than attempt to relegate to the dark ages the earth road problem, we must face conditions as they are and as they will be for many years to come. We must realize that the earth road question is a problem—a neglected problem and that it must be solved. More attention must be given to earth road construction and more intelligent care must be given to maintenance.

One of the main reasons for poor earth roads is absolute lack of system in either construction or maintenance. It has become largely a custom to neglect entirely any thought in connection with either the location or construction of this character of road. In no small measure, this is due to our political system. The road foreman is often a man appointed for political effect and with no qualifications for his position. But little can be expected of such appointments and but little is secured. A change in the system would work wonders, but even the system is not entirely to blame.

Like every other kind of construction work, to be successfully built and maintained, earth roads depend upon several essential requirements. Two of these are the drainage question and the grade and alignment. Upon the way in which the surface water is handled may almost be said to depend the life of the road. If the drainage is badly or carelessly handled or allowed to go neglected, certainly it means the destruction of the road. So, too, in a large measure is the life of the road dependent upon the proper alignment and grade. Oftentimes a change up the hill or down the hill; a curve installed here and one eliminated there; or a new channel for the neighboring small creek will mean salvation for the road.

The Drainage

Too much cannot be said of the importance of this subject. It is important in connection with any character of road construction, but taking into consideration the soft surface of an earth road the drainage becomes doubly important. It is not a simple question easily handled, but requires much study, dividing itself naturally into several divsions. The road must be so well crowned and so evenly and well built that the rain water will never stand in pools. Then again there is the subdrainage. Often the road will be underlaid with springs. Or it may be built in wet marshy ground. The side ditches along the road are likewise im-

portant. They not only care for the water shed by the crowned road but they intercept and carry off the water coming to the roadway from the adjacent country. The cross culverts make another interesting study and much time and thought is necessary to obtain culverts sufficiently large and of such a character to carry the water away. The crown of the road answers the same purpose as the roof of the house. The purpose of the crown is to shed the water from the road. If the crown is too flat water will collect in slight depressions and continuous traffic increases the depressions to a good sized hole. If the crown were sufficient to drain the water falling to the side ditches the road surface would be kept comparatively dry. The amount of crown depends upon a number of things, such as width of roadway, the grade of the road and the character of the soil of which the road is built. Only sufficient crown should be given to the road to do what is required of it. Too much crown will force wagons to one side of the road and off the road surface proper.

Subdrainage is not always required but in seepy or marshy ground is a necessity. Water can be gotten off the road easily but ground water is sometimes a serious problem. A road cannot be maintained in wet ground. Sometimes blind rock drains will carry off the water. At other times it may be necessary to underlay the road with longitudinal or transverse tile drains. Each problem must be worked out on its own merits.

The side ditches if properly built will many times drain a damp roadbed. These ditches, too, care for the water shed from the surface of the road by the crown. They play an exceedingly important part and must be looked after at all times. Even when subdrainage is not needed good side ditches are always required.

Bridges and cross culverts must be supplied ever so often. These are required to distribute the water to natural channels so that the side ditches do not carry too much water. Cross culverts require a great deal of care and attention. If they are too large they run the expense needlessly high. If they are too small, the heavy rains not only take out the culverts but the road as well. Too many times boxes and culverts are put into a road without any care or thought, only to be washed out with the next freshet because of insufficient capacity or careless location. The writer recently had several hundred feet of a road, because of improper culvert location, washed entirely away. This road was built up to a height of some five or six feet and culvert openings

were made too small when the road was constructed. During a very heavy freshet, the strain became too great and part of the bank gave away. This opening allowed a current and volume of water to go through the roadway, which took everything before it. A small bridge would have cost but a few dollars and saved several thousands.

Grade and Alignment

The other very important question is the grade and alignment. While the road may be built and traversed, and become very useful on a poor alignment and with a steep grade, the question of cost in hauling over the road is an item to which serious attention should be given. The cost of future maintenance also enters largely into consideration and drainage bears intimate relation to gradient and alignment. It is far more difficult to maintain ditches on a steep grade or crooked road than on a flat straight road. However, it is principally upon the cost of hauling that the grade has its important bearing. If a farmer is eight miles from market and has just one hill, say a thousand feet in length on a ten per cent. grade, he loads his wagon so that he can pull the ten per cent. grade. If the rest of the grades are no steeper than three or four per cent., it makes no difference. He must load his wagon for the one steep grade. In the course of a year the loss to the farmer because of this grade becomes enormous. The old adage, "A chain is no stronger than its weakest link," was never applied more aptly than in this connection. A team is capable of hauling over every road only what can be hauled up the steepest grades.

The grades upon every road should be worked out with relation to the traffic in proportion to the construction cost. In other words, the amount of traffic in a large measure limits the allowable amount of expenditure for grade reductions. In the mountain sections railroads often cover many miles to reach points in a straight line only a few miles apart, but the grades allowable require the additional mileage.

In theory the best road is the short road, but in practice this is not true. It is far better and will mean a great saving in transportation costs to detour so as to avoid the heavy grades even at the expense of distance. On a five per cent. grade it is estimated that a horse will pull about one-half as much as on a level road. On a ten per cent. grade it will pull not over one-fourth as much. The necessity for grade reduction becomes very apparent in the immense saving in transportation.

Again, while oftentimes a deviation from the straight line will cut out heavy grades, there are other causes for alignment changes. Bridges are not only expensive, but they are troublesome in times of freshets. The fewer bridges one has in his road the better. Oftentimes by changing the course of the road a creek crossing may be avoided and the road gotten up and away from the creek bed.

Maintenance

A successfully kept earth road means a constantly maintained earth road. There are so many things to affect the road that each one must be looked after. The little soaking showers soften the surface and the vehicles rut the road. The washing rains follow every rut collecting more water as the little stream flows down the roadway until it leaps over the side and washes a "gully" in the berm to the ditches. A rock or a stick in the surface makes a hard spot. Wagon wheels drop off to the softer earth and the little hole soon becomes a big one. This goes on until the road becomes a series of holes and high spots. Then during the dry summer weather the soil is pulverized. Dust particles are mixed with pulverized vegetation and animal excreta until there is no cohesion of the particles. The dusty material has no life. It is worthless, becoming soft with the slightest rainfall and unfit for the road in wet weather.

During the dry weather it is so soft and light as to become a terrible menace. Maintenance is not a difficult proposition, but it is a case of "eternal vigilance" and constant, intelligent care.

More harm is done earth roads because of unintelligent work in an endeavor to maintain them than can be estimated. The constantly recurring drainage question is ever at the front. The great Richelieu once said that three cardinal traits were necessary to a successful career, "the first, audacity; the second, audacity; and the third, audacity." So with earth roads the three cardinal requirements are drainage, more drainage and again drainage.

To properly maintain your road the culverts must be kept clean, the cross ditches clear and the side ditches always open and free from obstacles to impede the rapid flow of water. Willows, weeds and underbrush must be kept down and the bottom of the ditches clean. Side ditches play such an important part on road maintenance that almost the first requirement is to keep them open and free from obstructions. Upon these ditches depends very largely the drainage of your road. The surface cannot be kept dry unless the ditches

are of sufficient depth to rapidly take off the surface water, and unless the ditches are free from obstacles the free flow of the surface water is impeded and oftentimes so stopped and dammed as to force it back into the road.

Especially is the condition dangerous on the steeper grades. Surface water on grades flows so rapidly that once it gets out of the ditches into the roadway even the little rains make great gullies. The hillside roads, too, are very difficult to maintain because the surface water has a tendency to follow the ruts made by horses and vehicles rather than run into the side ditches. They demand a great deal of attention and care.

Closely related to the side ditch problem is that of the crown and surface of the road. If the road is kept well crowned and well surfaced, the water will easily flow into the ditches. Too often, however, when a road begins to flatten out, a grader is put into service and the weeds and grassy soil from the berm are scraped into the middle of the road. Continued traffic over the road has already pulverized the top soil and mixed it with vegetable matter and animal excreta until it has become absolutely dead and unfit for road material. In the dry weather it is a powder blown by every little breeze. In wet weather it is a mushy material with no bottom and splattering everywhere. The weeds and grass roots only make matters worse.

Instead of dragging anything to the middle of the road on top of this material, it should first be dragged off the road. It is better for fertilizer than for road material. Then clean, fresh material, fit for road surface and free from weeds and a surplus of grass roots should be dragged to the roadbed with your grader and this material properly surfaced. The new material should be good, fresh soil and left surfaced, free from bumps, holes or clods of earth.

In keeping an earth road in shape the road drag is indispensable. Every rain will soften the road surface and traffic will necessarily cut it up. Traffic cannot be kept off the roads and means must be devised to care for them so that traffic will injure them the least possible amount. The road drag is a real necessity. It surfaces over the road following the rain, presenting a smooth, compact roadway to traffic. Continued, intelligent use of the drag will keep the earth road in good condition at all times. Do not get the idea, though, that the drag will build roads. It will not. It is a boon in maintenance matters, but only after the road has been properly built.

Summing up, then, the essentials in proper maintenance,

the writer will say that if your drainage ditches are kept open and clean; your roadway well graded up and properly crowned after rains and when ruts appear your road carefully dragged, the problem of successful earth road maintenance has been solved. The first principle that must be learned, however, is that it requires eternal vigilance. One cannot neglect his earth road for any great length of time. It must be looked after and cared for all the time. It requires systematic effort and constant care. It may not be much work this week and but little next week, but the little work needed must be done just when needed or the road cannot be maintained to its highest degree of usefulness. A little care just when needed saves a great deal of work and expense a little later. Successful earth road maintenance we might say, is constant watchfulness and a little intelligent, but simple work as often as is necessary.

The writer has not gone into the detailed methods of either construction or maintenance. The time limit for this paper is too short for an extended discussion of this kind.

An effort has been made, however, to put clearly before you, for your consideration the few things essential in construction and maintenance, and it is the hope of the writer that these few remarks will result in good.

It is our desire, in conclusion, to impress upon you, and impress strongly, just these three important points:

The first is that earth roads are really roads, are necessary roads, and that the earth road problem must be dealt with by highway engineers and others.

Secondly, earth roads can be well constructed and that there is wisdom in constructing them intelligently and with care.

The last point, intelligent and constant maintenance, is the secret of good earth roads.

CHAIRMAN PARKER: Gentlemen, that is a very interesting paper on a very important subject, and I want to express my appreciation for the effort made in preparing so excellent a paper.

The next paper, gentlemen, is that of Mr. E. J. Watson, Commissioner of the Department of Agriculture, Commerce and Industries of South Carolina, entitled "Sand-Clay Roads." Is Mr. Watson here? If Mr. Watson is not here, I am going to call on Dr. Pratt of North Carolina to say something upon this subject:

DR. PRATT: Mr. President and Gentlemen: While I have not prepared any paper on the sand-clay road, yet I am very

glad to be able to say just a few words, so that the paper that Mr. Watson probably prepared on this important type of road shall not go by the board, because I believe, while at the present time, the sand-clay road is being utilized for the most part in the southern states, it is a type of road that can be built profitably and have a good life farther north than it is being used at the present time.

SAND-CLAY ROADS

By DR. JOS. HYDE PRATT
State Geologist and Engineer of North Carolina

In the first place, a sand-clay road is a mixture, in certain proportions, of a certain kind of clay and a certain kind of sand, if you are going to get the best results; and although the name "sand-clay" sounds as though it would be a pretty easy road to build, yet, if it is not built right, it does not give you the results that you should expect. Now, approximately, in building a sand-clay road, we have 80 per cent. of sand and 20 per cent. of clay, simply a sufficient amount of clay to fill in the voids that exist between the grains of sand when each grain of sand is touching another. A stiff red plastic clay or brick clay is a type of clay that will make a good sand-clay road. The type of sand we need is the sharpest grit that we can get, and any of you that are at all familiar with the sands that are used in making mortar know the type of sand we want in making a sand-clay road—a sharp sand and a coarser sand than is usually used in the manufacture of mortar.

It may be of interest to some of you to give, just briefly, the method we use in many places in the construction of the sand-clay road. If we could always find it possible to make that road when it was raining and had all our materials adjacent to the road so that we could put them on when it was raining and the roadbed was wet, we would get splendid results, but as a rule we have to make the road when it is dry. We plow up that red clay to a depth of 3 to 3½ ins., then add 4 ins. of sand and harrow it in with a disk harrow, and then add 4 ins. more of sand and harrow that in. That is approximately the right percentage of sand to go with the clay that we plowed up. Then the road is dragged and crowned and left until it rains. Up to the present time we have done nothing with that road that will make the clay bind the grains of sand together. When it is raining, open up the road with a harrow so that the water can get down into it and moisten every particle of clay; then round it up again,

crown it and drag it, and when it is dried out that road sets almost like cement and you have got a hard surfaced road.

Now, the question has been raised whether a sand-clay road will stand up where we have frost and freezing weather. If that question had been asked me in the summer of 1909, I would have had to say, "I don't know;" but in the fall of 1909, two miles of sand-clay road were built in Buncombe County, North Carolina, up in the mountains where they get a great deal of freezing weather and a great deal of frost. That road has probably had not more than $50 or $75 spent on it since that time for maintenance, and yet today it is considered one of the best pieces of road in the county, and they have a great many miles of macadam. That seems to indicate that the sand-clay road can be used—can be built as a good road—in other sections besides the southern states, and I believe that it will pay some of the highway commissioners who are here today to investigate the sand-clay road and see if a road which we call a sand-clay road, or a similar type of road, cannot be used in states outside of the territory that we designate as the southern states.

We may very often find that we've got plenty of clay but no sand. It is a feasible proposition to make your own sand if you have got veins of quartz cutting your rocks or if you have got a good trap rock. You can crush that rock and take it out and screen it so that you get particles of grits about the size of the end of your little finger. Mix those on the road in a way similar to that I have suggested for the sand and clay, and you will get similar results. Here in certain sections of the north you also have soil similar to that we have in the south. We call it in the south, in a great many sections, a tobacco soil. It is a soil composed of particles of clay and a great deal of sand. Very often that particular type of soil has a mixture of from 60 to 70 or 75 per cent. of sand, the balance being clay. We have found that we can take that material and use it for making the sand-clay road. The road is then called, with us, a "top soil" road. You have got, in certain sections of the northern states, a similar soil that I believe that you can use in making a top soil or a sand-clay road, and I don't believe—that is the reason I wished something to be said regarding sand-clay roads —I don't believe the sand-clay road is adapted simply to the South. It is a road that can be used in many of the northern and probably in some of the western states, and you will find that it is a road that stays as hard as a hard surfaced road for 365 days in the year.

We do not call a sand-clay road a dirt road very often. In

the classification of roads, we speak of the dirt road as representing the ordinary dirt surface, sand, clay or gravel. We make a decided distinction, and we speak of and consider the sand-clay road as being a hard surfaced road, and it has been the salvation of the surfacing of our roads in a great many of the southern states, and I believe it is worth the attention of a great many of the commissioners of the other states to see if they cannot take some of their roads that they are leaving as dirt roads and give them a hard surface. You can turn the proposition around and take a heavy, sandy soil and add clay to that and work that in and make what you call the clay-sand road. It is the same proposition except that you are reversing the method of operation in making the road. But I would also state, in that connection, that you will find that the results are harder to obtain when you add the clay to the sand than when you add the sand to the clay, because it is not so easy to get the two thoroughly mixed. But in the end, if care is taken in the preparation of the road, you do get splendid results, whether you are making the clay-sand or the sand-clay road. Thank you. (Applause.)

CHAIRMAN PARKER: Is Mr. Cooley here? Mr. Cooley has already sent in his paper, as he was in doubt whether he would be here. If he is not here, Major Crosby will be kind enough to read his paper.

GRAVEL ROADS

By GEO. W. COOLEY
State Engineer of Minnesota

The object of this paper is not to claim for this method of construction any great superiority in road surfacing, nor to advocate its use to the exclusion of other well tried and more satisfactory plans, involving the use of brick, stone, concrete or other material. But in looking over the field we are confronted with this potent factor in the road problem:

We have 2,000,000 miles of earth road, of which, say 1,000,000 miles should and perhaps will be built of material capable of withstanding the ordinary wear and tear of daily travel for perhaps 365 days in the year. Suppose we built this million miles of concrete or brick at the lowest rate, or $12,000 per mile; the bill would amount to $12,000,000,000. Plainly, then, such a proposition at this time is unworthy of consideration. Reducing the cost to that of average macadam, or about one-half that of brick or concrete, we still

have resultant figures that would not be considered for a moment by any intelligent engineer or taxpayer.

My only object in using the above figures is to point out the absurdity of the demands made by some enthusiastic but misguided advocates of good roads, that "Nothing is too good for this country and we must have the best there is regardless of cost." We certainly want the best, but in getting it we are obliged to consider the cost and so outline our plans that we may have some other of the necessaries and luxuries of life without bankruptcy. Between the two extremes of any proposition there is generally a golden mean. We have as one extreme the brick or concrete road, well suited for heavy, or rapid and continuous travel, and in all probability the most economical for a long term of years. For the other extreme, considering cost only, we have the common earth road, the same one that our forefathers built; available only when conditions were favorable; but under such conditions the easiest and most comfortable, most satisfactory road ever used. But however carefully an earth road is built it is subject to have at times, under stress of weather, periods of depression, when it is practically out of commission; and generally these periods come at a season of the year when the road is most needed.

What appears, then, to me, to be a road approaching this golden mean, is one having approximately the same qualities as a good earth road; that is, comparative ease of traction, sufficient resilience, freedom from injury to hoofs, and far less cost than the cheapest stone or brick or otherwise hardened surface. I know of no material which answers the above requirements in a higher degree than gravel.

The Minnesota specifications describe suitable gravel as being composed of 75 per cent. of pebbles from ¼-in. to 1½ ins. in size with 25 per cent. of sand and clay. A small quantity of iron oxide and lime makes it still more acceptable. The latter ingredients are not generally found in river gravel but are frequently noticed in pits or banks. Any gravel that stands for a long time with a vertical face may be deemed to give a satisfactory surfacing to an earth road. Even such a gravel needs, at times, a certain amount of doctoring, and I have found it advantageous to add from 5 to 15 per cent. of sand where the sub-base is clay, or that amount of clay when the base is sand. The base should, of course, be prepared with as much care as for a road of broken stone, and the material as carefully deposited; also the usual precautions should be taken for suitable drainage.

In depositing the gravel on the roadbed the man at the

dump should be provided with a rake, and instructed to rake the larger stones to the front leaving the surface free from stones over 1 in. in size. Another man should be required to rake the ruts and level up the low places so as to present a uniform surface. This is peculiarly necessary where circumstances require hauling over soft graveling. One requirement generally insisted on is that the contractor keep a man on repairs for at least 30 days after his contract has been completed, after which the state or county or town will put on a road patrol whose duty will be to keep the ruts filled and the surface smooth. This patrol system I consider not only advisable but absolutely necessary in case of all gravel roads, especially on those newly built; and the patrol should be instructed to not only keep the surface smooth and with a uniform cross section, but he should by the use of temporary obstructions divert the travel occasionally from the regular beaten tracks so as to further assist in the process of compacting.

In many localities the gravel road of today may in the course of a few years become a macadam or brick or concrete road, and where such a probability is presented the subgrade should be dropped about 6 ins. Unless a gravel road is rolled in thin layers it will require a full year of careful maintenance for it to reach that stage of excellence required by most agricultural communities. Rapid travel of automobiles will, of course, dislodge a quantity of the surfacing and cast it to one side of the metaled way and such material should be at once replaced in the ruts. It is important that this work of repair should not be left until machinery is required to bring it back to the road, for such use will surely result in a deposit of unsuitable material on the gravel and the road will rapidly deteriorate. As to the proper width of graveling, the Minnesota Highway Commission has adopted 16 ft. for a double track road, which requires about 1,600 cu. yds. of gravel or approximately 100 cu. yds. for each foot in width. In the construction and use of all roads, especially those built of gravel, a proper system of maintenance is absolutely demanded, and such a system will cost from $50 to $75 per mile per year, provided a suitable supply of repair material has been deposited alongside for the use of the patrolman who should be supplied with a wheelbarrow and a small kit of suitable hand tools.

By a careful compliance with the specifications and the exercise of a little good common sense, I believe that a good gravel road well kept will be found to be, for most of the year, as reliable and economical as many more expensive

roads. The usual cost of such a road will run from $750 to $2,500 per mile, depending mainly on the length of haul.

CHAIRMAN PARKER: I think Maj. Crosby read that paper as well as if he had prepared it himself, even if he did not agree with the writer on the subject. (Laughter.)

The next paper, "Concrete Roads," has been prepared by Mr. F. F. Rogers, State Highway Commissioner of Michigan. Mr. Rogers has gone out on some expedition of his own and has asked me to get somebody to read this paper. I am therefore going to ask Col. William DeH. Washington to read it.

CONCRETE ROADS

By FRANK F. ROGERS
State Highway Commissioner of Michigan

Concrete can no longer be regarded as in the experimental stage as a surfacing material for country roads and on certain streets for city and village pavements. It has long been accepted as the most suitable material for the foundation of pavements for city streets, no matter what material might be used for the wearing surface. There has been a great deal of discussion, however, as to its suitability for a paving material when used for both foundation and wearing surface.

Unfortunately most that has been written both for and against concrete for road surfaces has come from persons directly or indirectly interested in the sale of cement, or on the contrary, interested in the promotion or sale of some other materials for surfacing both city pavements and country roads. Under such circumstances no matter how honest the writer may attempt to be his arguments and conclusions almost invariably coincide with his interests. We have Scripture for it, that "where the treasure is there will the heart be also."

The last five years have seen an immense yardage of concrete pavements laid in the cities and small towns of the country and a rather large mileage of concrete laid on country highways. Michigan, Wisconsin, Illinois and Iowa are the states which seem to have been most active in this work.

The writer has observed pavements built of this material in many cities, and has seen all the concrete roadways that have been built in Michigan, possibly 75 miles in all. A paper giving the results of a rather minute study of some thirty miles of the concrete roadways in Wayne County,

Michigan, was prepared by him for the American Road Congress recently held at Detroit, but as this paper has been published in full in most of the engineering journals no further reference will be made to it at this time. As to the pavements, it must be said that few of them are without defects, but most of these defects can be traced to the following causes:

(a) Too lean a mix.

(b) A poor aggregate.

(c) Poor foundation, including inadequate drainage.

(d) Lack of suitable expansion joints properly spaced.

And it should be added that about all of the observed defects in concrete roadways can be traced to one or more of the above causes.

A large percentage of the defects in city and small town concrete pavements may be charged to a lean mix, especially where two-course concrete has been laid. There has been much talk about satisfactory pavements of this kind at a cost of from 75 cts. to 80 cts. per sq. yd. Any attempt to build concrete pavements or roadways at these prices is a sure bid for failure. Under favorable conditions and with careful workmanship the writer believes that the two-course pavement can be made a success. If so the top layer must be put on before the bottom layer has had time to take the initial set, and the mix should not be leaner than 1: 2½: 5 for the base, nor than 1: 2: 3 for the top. I would prefer a one-course concrete with a 1:2:3½ mix, taking great care in the selection of the aggregate both as to hardness and toughness of the crushed rock or pebbles, and in the proper grading of both the coarse and the fine aggregates so that the utmost possible density would be secured.

Experience thus far has convinced the writer that it is much easier to secure a satisfactory cement than to secure a suitable aggregate. Results in Wayne County, Michigan, seem to favor washed pebbles and sand rather than crushed cobbles for aggregate. This is rather hard to account for when one considers that the pebbles represent about the same variety and character of rocks that we get in our cobbles. It is quite possible that a better gradation from fine to coarse is secured with the pebbles, thus making a denser material. No matter what the theory there can be no question but the pebble concrete makes the most durable surface and one which wears more evenly.

In the accelerated tests on two sections of concrete and two sections of brick made at Detroit during the recent road congress, the concrete in which Wisconsin granite, a

rock as hard and tough as most traps, was used for the coarse aggregate, wore much better than the section where washed pebbles were used. It should be stated, however, that the price of Wisconsin granite delivered in Michigan is too high to allow it to be extensively used as an aggregate either for concrete pavements or roadways. The only materials that are commercially available at prices that can be considered are washed pebbles, crushed cobbles and limestone. So far the latter has been used but little for this purpose, but I am of the opinion that the best grades of lime rock are worth considering in this connection, especially on the secondary roads. The limestone (which is a dolomite) would at least wear evenly which is not true of the cobbles owing to the varying degrees of hardness and toughness in the different varieties of rocks found among the cobbles in our state.

To avoid cracks the foundation must be absolutely stable and free from water at all seasons of the year. Where old traveled highways can be used for the foundation with only enough changes of surface to make a smooth subgrade, the conditions are ideal. Where such conditions are found in Wayne County long stretches of roadway 15 and 16 ft. wide may be seen perfectly free from longitudinal cracks. On the other hand any cut or fill more than one or two feet in depth is almost sure to produce longitudinal cracks in the concrete, unless it is very narrow.

Experience has proved that from 25 to 33 ft. is a suitable spacing for transverse joints. By way of experiment a 150-ft. stretch of 16-ft. roadway was laid on Michigan Ave., Wayne County this year without expansion joints of any kind. Before the road was opened to traffic nature had supplied the transverse joints spaced from 18 to 26 ft. with one extra thrown in for good measure.

Any kind of crack except the expansion joints in a concrete roadway is some reflection on the design, workmanship or material. There is no doubt that if all the knowledge we now have on this subject were utilized in design and construction, pavements and roadways of this material could be laid that would remain almost free from the defects named. There is some question, however, if to do so would not make the expense of the pavement or roadway so high as to be practically prohibitive. So far the cracks that have been found are not more difficult to handle than the expansion joints and apparently are not much more objectionable except for their unsightly appearance when repaired. However, if they should eventually become too numerous they

would necessarily cause the destruction of the pavement or roadway.

MAJ. W. W. CROSBY (Chief Engineer, Maryland Geological and Economic Survey, and Consulting Engineer, Baltimore, Md.): I don't want to take up the time of the convention unnecessarily and I realize that it is late, but before you pass to the next subject I would like the indulgence of the meeting for about two minutes merely to present one point in this connection. Is discussion from the floor in order?

CHAIRMAN PARKER: Considering, Major, your recognized ability and that, I think, you are well known to everybody here, I think, without asking the assembly, we will permit you to go ahead.

MAJ. CROSBY: While at present there seems to be a sort of a stampede, ably assisted perhaps by certain interests, toward the use of concrete for roads and streets, the speaker wishes to utilize this opportunity to express the opinion that the selection of concrete for such work may well be considered as divided into two main questions of great importance for proper determination.

The first of these questions is that of a necessity for rich concrete or even for a concrete base per se, for the pavement or wearing surface itself—a condition by no means always existing or likely to exist during the life of the wearing surface. Many mistakes it seems to the speaker have been, and are being, made by the use of any concrete base or foundation where equal satisfaction at least and great economy would have been had by its omission or the substitution of a cheaper but, under the local conditions, an equally efficient foundation. It is to be understood here that the speaker believes that the use of concrete for the wearing surface itself, except in a few cases under peculiar conditions, is already proved impracticable, but for the sake of brevity the reasons for this conclusion will not be again expressed here.

The second of the questions referred to is made up of the old questions as to (a) the character of the wearing surface to be supplied on top of the concrete base or foundation, and (b) the thickness of such wearing surface.

As to (a), the character of the wearing surface to be built, little need be said at this moment for the purposes of the speaker.

The point which the speaker wishes to make at this time is under (b), the thickness of the wearing surface when the

latter is bituminous in composition. Wearing surfaces composed of pitch compounds (bituminous materials such as asphalts, tars and oils) mixed either previously or *in situ*, with sand, gravel or stone chips have almost invariably proved unsatisfactory as carpets on concrete unless these carpets have been of more than a minimum thickness, dependent for expression in figures on local conditions, while those of sufficient thickness have proved satisfactory where their construction was proper under all the conditions.

The speaker thinks a reason for this difference in results between carpets identical except in thickness and for the failure of many too thin carpets comes from the fact that the thin carpets do not sufficiently absorb the shocks of traffic to prevent disintegration and pulverization to a greater or less degree by such shocks, of the surface of the concrete to which the carpet is applied. Hence such carpets, lacking sufficient coherency in themselves and the preservation of a proper surface to which to maintain their adhesion, soon break up and disappear, first in spots and then altogether.

The surface of the concrete base naturally contains a great deal of mortar—an extremely friable substance, readily disintegrated under horses' feet and hard tires. If the effect of these is permitted to pass through the carpet and to reach the mortar the latter soon becomes broken up and the adhesion of the carpet to a stable surface destroyed.

The same phenomena have been noticed by the speaker in the cases of macadam built of a soft friable sandstone covered with a thin carpet, and their failure to occur has been equally noticeable where the thickness and character of the carpet has been sufficient to absorb the shocks and to prevent disintegration of the friable materials underneath.

The speaker realizes the difficulties of thick carpets but he feels they can be solved by proper methods such as have been used in the case of a familiar form of carpet for city streets—the sheet asphalt pavement. He believes that further solution of the problem of adapting this pavement to country roads—by the substitution of a "paint coat" for the "binder course," for instance—is in sight. But this, too, "is another story."

COL. WM. DeH. WASHINGTON (New York, N. Y.): Mr. Chairman, may I say less than ten words on this?

CHAIRMAN PARKER: You may say nine. (Laughter.)

COL. WASHINGTON: All right; I want to say this: From my own observation, a good many of the longitudinal cracks in concrete roadways, in my judgment, are due to

carelessness in making firm the boards or forms on the sides, between which the concrete is laid, by driving strong pins into the ground. Those forms frequently spread if the concrete is mixed very wet, and the crack is formed before the concrete sets up.

I found in Michigan, where they took care of that matter, that they had a great many less longitudinal cracks than in some places in the state of New York where I noticed that the fellows would go along and stick down any kind of an old stick. I think that more care in making firm the forms will have a material effect in the reduction of longitudinal cracks, I do not care what your base is. (Applause.)

CHAIRMAN PARKER: The next paper is upon "Brick Roads," by Mr. J. M. McCleary, of Cleveland, Ohio. Is Mr. McCleary here? If not we will proceed to the next paper, which is "Wood and Asphalt Block," by Mr. H. H. Schmidt, Chief Engineer of the Bureau of Highways of Brooklyn, New York.

WOOD AND ASPHALT BLOCK

By H. H. SCHMIDT

Chief Engineer, Bureau of Highways, Borough of Brooklyn, N. Y.

Pavements are supposed to be designed to meet certain requirements. No one pavement is known that will meet all. If one pavement is best suited to the most severe conditions, it is not necessarily the best pavement for less severe ones. Somewhere in the scale of pavements, between the ideal one and the so-called pavement which is destroyed in a comparatively short time under light traffic and by the action of the elements, might be placed all known pavements in the order of their value. I will not attempt to tell you just where, in this scale of pavements, wood and asphalt block pavements should be placed, though I will say that neither one is the ideal pavement, except in the opinion of the respective manufacturer, and still both of them stand well up in this scale of pavements.

Wood Block Pavements

Wood block pavements are suitable for streets where the factor of elimination of noise is an extremely important one, and where the traffic is quite heavy. Probably every one who has had considerable experience with this class of pavement has obtained many splendid results, but also some failures. These failures in wood block pavements are entirely different from failures in any other class of pavement. They are due almost invariably to the expansion of the

wood, and within a short time a perfect street may become a complete wreck.

Another source of great annoyance with this pavement, though not to my mind an extremely serious condition, is caused by the so-called bleeding of the blocks. This bleeding is always, where it occurs, a matter of much concern to the one responsible for the condition of the pavements. The bleeding generally ceases after the block has been down a few years.

In no other pavements do we have these two conditions to contend with.

The important question, and the one which is occupying the minds of many who have to do with this class of work, is the expansion of the block. The nature of all wood is such that it expands or contracts as the amount of moisture to which it is subjected is increased or diminished. If it were possible to lay blocks in their most expanded condition we should not have trouble with expansion after the pavement is laid, but it is very seldom that blocks are in this condition at the time of laying. For this reason we must give consideration to many matters which are involved when this class of pavement is used. Traffic, treatment of the blocks, their condition before treatment, their condition when laid, surface drainage of the pavement, the width of roadway, the amount of moisture or water to which these blocks will be exposed, and the length of time they are subjected to the wetting, are all matters which must be taken into account if failures are to be avoided.

It might be said that where failures in wood block pavements do occur, they are due to a lack of knowledge, or a lack of provision for the essentials which must be considered to provide against bulging under certain adverse conditions, and I look for fewer failures as these various matters are better understood and better provided for.

The specifications in use in the various localities in this country at the present time are on the whole very much alike, and there is no question but what they will provide for a wood block pavement which, under all ordinary conditions, will give splendid results. The important elements upon which the modern practice is based are: The character of the timber, the size of the blocks, the character of the oil, the treatment of the blocks and the method of laying.

More attention has been given to the size of blocks, character of the oil, and the treatment of the blocks, than to any other features of the wood block pavement. That they are very important questions it is unnecessary to state, and

yet the character of the timber, its condition at the time of treatment, and the method of laying the blocks are more important features than the size of the blocks, the character of the oil, or the method of treatment.

We are, of course, limited to certain kinds of timber, and are pretty well satisfied that a good, sound southern yellow pine is about the best available timber, if it is in proper condition for treatment.

As to the method of laying, this is a matter which does not seem to have been given the amount of attention which it warrants. We are not justified in using or in laying the blocks in identically the same way under all conditions, and I have been particularly impressed with the results which can be accomplished where failures have occurred, with blocks which are identically the same as the ones that failed, by adapting the method of laying to the circumstances which have contributed to cause the failure.

Specifications for laying wood block pavement should give consideration to the relation between the width of pavement surface, the treatment of blocks, and the size and location of expansion joints. The width of joints between the blocks must also be considered. No one seems to wish to commit himself on this question of width of joints. Some specify tight joints and some open joints, but this is merely a relative description, which means little or nothing.

There exist today wood block pavements laid ten and more years ago, where the blocks were laid so close that they all touched one another and entirely without expansion joints, and yet many of these pavements have never bulged in the slightest degree. On the other hand, we have some new pavements, which seem to have been amply provided with expansion joints, and which have bulged badly. In every case, however, the old pavements which did not bulge were laid on streets where the local conditions for a pavement were of the best, while where considerable bulging was experienced, the local conditions generally were bad and were not properly provided for.

A wood block pavement is one of our highest types of modern, smooth, clean, noiseless, and durable pavements. The two faults pointed out should not detract from its use, but it is essential that the bleeding be eliminated by the proper treatment with preservative oils whose properties are such that they will not cause the block to bleed, and it is further essential that the blocks be so laid that they have the opportunity to expand without bulging, if they are not laid in a fully expanded state. Intelligent investigation and

experimentation will, without doubt, in time overcome both of these difficulties.

Asphalt Block Pavements

Asphalt block pavements are not well known in many parts of this country. In the vicinity of New York, however, they have been used to a considerable extent. The coarse aggregate which is used in the mixture makes them less slippery than sheet asphalt, and we find them used largely in New York City on grades where a pavement less slippery than sheet asphalt was desired, and yet where the character of an asphalt pavement was to be maintained. Asphalt block should not be used on heavy traffic streets, particularly where there is considerable steel tire traffic, as the life of the pavement is very short on such a street. On the other hand, they have given splendid results on automobile roads leading from the city into suburban districts.

The asphalt block pavement is particularly suited to villages or country districts, not large enough to support an asphalt plant, as no plant is required for the first construction, nor for the maintenance.

Many asphalt blocks which have been manufactured in the past have been complete failures, and have been the cause of creating a strong prejudice against this material. The specifications for asphalt blocks generally provide for: The size of the blocks, the composition of the blocks, the character of each ingredient, the specific gravity of the block and the method of laying.

The failure of asphalt block pavements is due to entirely different causes from the failures before described under the wood block pavements. We do not have the question of bleeding or expansion to deal with. The difficulties in this class of pavement have been to secure blocks which have been manufactured with proper ingredients, mixed in proportions which make them fit to withstand the wear and tear of traffic, and blocks which are properly molded and compressed. The specific gravity has been considered as an index of these requirements. The size of the blocks and the method of laying are both, of course, of importance. It is essential that the blocks be of sufficient size to have stability, and that they be laid in such a way as to be held rigidly in place.

Asphalt blocks are composed of asphaltic cement, crushed trap rock, and mineral dust. Considerable difficulty has been experienced in producing a block which would answer the needs of traffic, and at the same time one which would not

deteriorate rapidly under the climatic conditions to which it was subjected. The successful manufacture of such a block undoubtedly requires a tough asphaltic cement; that is, one which will produce a block the edges of which will not "ravel" under traffic in winter, and, secondly, a proper proportioning of such an asphaltic cement to the trap rock and mineral dust, so that the block will not elongate or "shove" under traffic in summer. In almost all cases where an asphalt block has failed the failure has been due to disintegration, and the amount of asphaltic cement which the block contained was very small as compared with the amount of asphaltic cement in an ordinary sheet asphalt pavement.

A great advance has been made in the last few years in this direction, and blocks are now being manufactured which are standing up well under considerable traffic, and which at the same time contain sufficient asphalt, so that their lasting qualities will be greatly improved. Machines for molding and compressing the blocks have also been improved, and without question, some of the asphalt blocks which are now being manufactured, measure up very favorably with other standard types of pavement.

RICHARD L. LAMB (New York, N. Y.): Mr. Chairman, I should like to make a few remarks in regard to wood block pavements.

Gentlemen, the engineers of this country have had brought before their attention, in probably as thorough a manner as any propagation of an industry could possibly be brought, wood block paving; and I believe that most all of us engineers have been perfectly satisfied to take what has been brought to us and do no thinking for ourselves.

I have had ten years' experience in wood block paving and I find that the heavy oil, the 1.10, and up, specific gravity oil, which is most all pitch, is the cause of much of the trouble we have heard Mr. Schmidt speak of. If you notice the specifications of blocks treated with heavy oil, you will find they demand that the treated block shall not absorb to exceed 3½ per cent. of water. All light creosote oils, 1.03 up to 1.07 specific gravity, treated blocks will absorb 4½ per cent. of water. Why do they want a specification for that percentage of absorption? If, when treating with heavy oil, they don't subsequently treat the blocks with cold pitch, they will have blocks that absorb more than 3½ per cent. of water; but, with the cold oil or pitch treatment they get the same result that Noah did when pitching his ark. But for what purpose do you want to caulk the wood? Is it to keep

it from alternately wetting and drying in order that it may not rot? If so, you are after a wood preservative. There is no engineer here who will say that tar or 1.10 and up specific gravity oil will preserve wood. You never hear of creosoting companies treating lumber for other purposes with this oil. We all know creosote will preserve wood.

If you want to have it so that the water won't get in and cause the blocks to swell, then with which oil do the blocks swell the most, the 1.10 specific gravity or the 1.03? Gentlemen, my experience is that 1.03 creosote oil does not expand to any serious degree and when using that oil you are not troubled with buckling of the blocks; you lubricate and make hydroscopic the fibre of the wood. The water can go into the block, but the fibre is made hydroscopic, it cannot get into the fibre and therefore the block won't swell. We are told it is the water that makes these blocks swell. Sometimes when it is perfectly dry these 1.10 specific gravity blocks bulge up. If you take blocks and ram them full of pitch, especially heart pine blocks, and put them close together and cold weather comes on, if conditions are right, they will expand. If you use short leaf pine blocks, the expansion will be taken up in large part within the blocks themselves. You should use long leaf heart pine, as you generally do when using heavy oil, because you can have no faith in pitch as a preservative and, unless treated with real creosote, short leaf pine will rot sooner than long leaf heart pine. If you use creosote or light oil, then you can use short leaf pine and you will save about 20 cts. per sq. yd. in cost, and as the light oil expands under the influence of cold far less than pitch, you will not be bothered with buckling.

My practice is to lay the blocks close together. They should be dressed on four sides, which somewhat closes the pores of the wood, like hewing a tie. Use nothing between them as a filler but fine dry sand. This sand mixes with the creosote and makes an excellent binder. When brooming in the sand, you put in some between the blocks and broom it out again. You should put in sand to a certain extent by brooming—and it will be only a very little—and then put on a ½-in. layer of fine sand over the whole area of block laid, and let the traffic work it in between the blocks. It will work it in in about a month. There will be enough creosote exude on the sides of the blocks to make a mixture with the sand that consolidates and makes monolithic and waterproof the whole pavement, after which there is no chance for the water to get into the bed or into the blocks

if the pavement is properly graded. I want to say in conclusion that many of the cities are opening their specifications to the light oil blocks which all creosoting companies can furnish, and if you will study the subject thoroughly and impartially and disregard all commercial interests that are pressing their wares upon you, you will all decide to use the light creosote oil. (Applause.)

H. L. COLLIER (Consulting Engineer, Yellow Pine Manufacturers' Association): Mr. Chairman, I have up to this time remained quiet and let you carry through your printed program, which I considered the proper thing to do. I want to say, since Mr. Lamb has made his statement, I would like to have the privilege, as the Consulting Engineer of the Yellow Pine Manufacturers' Association, to have about three or four minutes to reply to Mr. Lamb and give information which I think would be of some use to the American Road Builders' Association.

CHAIRMAN PARKER: Can you make it in a few minutes?

MR. COLLIER: Yes, sir. Gentlemen, it is not with a view of throwing in a controversy at this point that I ask the privilege of addressing you. Possibly Mr. Lamb and I would agree on some points; on others he and I materially disagree. I have been engaged in the study of street pavement for 18 years; for five years I was connected with the United States government, for ten years Commissioner of Public Works of Atlanta and three years as Consulting Engineer of the Yellow Pine Manufacturers' Association. I have never heard Mr. Lamb quoted as being an authority on wood. I want to say, as one who is looked upon as an expert in wood, that it takes more than an ordinary expert to tell long leaf from the best quality of short leaf pine; they are so similar in construction and in appearance that not one man in a hundred who professes to be an expert can tell the difference. As consulting engineer of the Yellow Pine Manufacturers' Association, I do not discriminate between these two for wood block paving purposes. Long leaf pine has a greater strength and for engineering work is preferable. On street pavements they each have sufficient strength to satisfy the demands of a wood block pavement, and there is no difference, so far as we are able to tell, in the wearing qualities or the absorptive qualities of long and short leaf pine. The question of oils is a question that belongs to the wood preservers' association and to the chemists of the country.

As to the oil, I say a medium oil is my preference, and I'd rather have an oil from 1.06 to 1.10 than an oil from 1.10 to

1.14. I believe the lighter oil will preserve the wood. I attempt to overcome absorption, not by sand—I am very much opposed to a sand filler; it does not conform to my ideas at all of good construction; I believe it ought to be a bituminous filler, so fluxed as not to melt under the summer sun or become brittle under the winter cold. All of your troubles can be overcome by a proper construction of the pavement—if you will lay your blocks giving ample expansion room at the curb, close jointed lengthwise with ⅛-in. joints between the ends of your blocks. After the blocks have been rolled, put on the bituminous filler, such as I have described, heated up to 350 degrees, until it is as thin as water; you will not have any trouble with buckling or bleeding, and if you will put a pebbly sand on this coating while soft you will have very little trouble from slipperiness. I have given this subject a great deal of study, and in my experience I have had very little trouble either with the buckling or bleeding of the blocks. I want to impress upon you that the Yellow Pine Manufacturers' Association does not manufacture blocks. We take no part in the manufacture of the pavement at all. I am employed by the association for the sole purpose of going over the United States, studying the specifications of different engineers, examining their pavements under traffic and suggesting, where possible, changes that would be beneficial.

CHAIRMAN PARKER: The next subject is a paper on "Water Bound Macadam," and the person who is going to deliver the paper is your well beloved Deputy State Highway Commissioner of Pennsylvania, Mr. J. W. Hunter.

WATER BOUND MACADAM

By J. W. HUNTER

Deputy State Highway Commissioner of Pennsylvania

The macadam road of today takes its name from that illustrious pioneer road builder, a Scotchman, John Loudon McAdam, through whose influence the condition of roads in Scotland and England was greatly improved more than a hundred years ago.

Today, the "water bound" macadam road is considered by many as a relic of the dark ages and the road builder who advocates the laying down of such a road is apt to be considered a man with antiquated ideas, a fossil, a man far behind the times and speed of the twentieth century. The writer does not agree with this view. Every system of road or street improvement has its place in the great work of making better the roads and highways of today. A system of

highway improvement as used in the great centers of population, where the traffic is dense and almost indeterminable, if applied to the rural districts of the state would be considered a piece of folly not to be tolerated.

The brick paved road and the concrete road have their uses and are the types of road to be laid down in certain localities and on certain kinds of soil. The bituminous macadam and asphaltic macadam roads are in much favor at the present time, as having an ideal surface to travel over, being less dusty and more nearly waterproof than other surfaces and said to be less costly to maintain. This, however, is problematic and subject to experiment and proof.

For highways that are main lines and subject to extensive motor and other vehicle travel, the bituminous macadam, in connection with the brick pavement immediately adjacent to the centers of population is undoubtedly the better method of construction.

Along many of the most traveled roads, there is a neutral axis or section of the road that is but little used which can well be improved as a "water bound" macadam or telford macadam road. A macadam construction is all that is necessary on many miles of lateral roads or roads in a purely rural community, or where motor vehicle traffic is light, the cost of construction being less than that of other kinds of construction. The cost of maintenance, if properly done and done at the right time, will not be more than ½ ct. to 1 ct. per sq. yd. per year; and if this amount is expended each year the public will have a good surface to travel over all the time, not only some time, but all the time.

Water bound macadam has two faults as an ideal pavement for light traffic, or on the ordinary country road, one of which is its tendency to break up under motor vehicle traffic, and the other is the liability to absorb water. These can readily be overcome by the application of a bituminous wearing surface. In this connection and for the purpose of supplying a base for a bituminous or asphaltic cement top or surface, I believe that water bound macadam makes as good, if not better, foundation than concrete.

It has the inherent stability and lacks the creep or sheer in expansion and contraction of its aggregate. It is more resilient, causing less wearing on the surface, consequently permitting of a thinner wearing surface than a more rigid or unyielding concrete base. Water bound macadam that is well shaded will but seldom ravel or become dusty, as the moisture is held in place and not evaporated. Usually a water bound macadam laid on or over heavy, damp soil

does not become dusty but may ravel in very dry weather, but soon recovers after a rain or damp season. This is notably so where the surfacing is composed of limestone.

If water is convenient and properly applied to the surface of a water bound macadam road, no such road should ravel or become dusty. The water should be applied at night so that it may have an opportunity of penetrating into the surface and not be evaporated by the sun or converted into steam when applied to the superheated surface.

The watering of a road surface, if the material is adjacent to or of easy access, is a cheap method of maintenance, costing about two to three cents per square yard, where the price paid for water is from $75 to $85 per million gallons. If the water is obtained from a stream along the roadside the cost will be less.

The external forces to be overcome in traveling over a highway are usually gravity, friction, collision and air. Gravity and friction are in a measure overcome and the safety and economy of carriage provided for if the highway is perfectly straight and at the same time level—two conditions that are rarely obtained in the same road. The overcoming of the external force of collision, as well as that of friction, depends upon the character of the surface. A hard smooth surface offers the least oportunity for collision; friction and gravity are more easily overcome and consequently less tractive force is required in propelling a given load over a given distance. With a hard, smooth surface and a more rapidly moving vehicle, the air pressure, or resistance, becomes greater and in a measure counteracts the gains made for surface or wheel friction or traction.

What material will give the best surface for rapid, safe and economical travel and at the same time offer the least resistance to gravity, friction and collision and at the same time accommodate both horse and motor vehicle traffic? Bricks make a hard and comparatively smooth surface, but the external collision force is hard to overcome and presents a considerable obstruction or resistance to a rapidly moving vehicle; for heavy or slow traffic this resistance is not apparent. A concrete road is subject to the same criticism, except the collision force is not so great. Both brick and concrete surfaces are objectionable for horse traffic. The ordinary water bound macadam surface or telford macadam surface is a better surface for animal traffic, and if properly maintained is equally as good for motor vehicle traffic. The collision force will not be so great as on a brick pavement, but tractive force will be slightly increased.

The one surface that more nearly meets all the conditions as giving the least possible resistance to collision, friction and gravity in saving rapid, safe and economical travel and at the same time giving a surface practically dustless and waterproof, is the asphaltic macadam surface. The one drawback to such a hard smooth surface, which is not found in the water bound macadam surface, is its tendency to become slippery in wet weather, thereby becoming dangerous to horse traffic.

A better and more uniform surface of water bound macadam will be obtained when more care is given to the preparation of the foundation upon which is to be placed the crushed or telford stone; when more care is taken in the selection of the mineral aggregate, cubical instead of triangular, oblong or semi-round stone used, stones that of themselves will under traffic bond together and only of such hardness as will be kept bonded by the traffic, (much of the raveling of "water bound" macadam is due to the action of the elements and lack of sufficient traffic over the surface); when more care is taken in placing the top course of stone, spreading it in from the side of the road and not dumping it in the middle of the road and then spreading or leveling the material; and with more care in applying or feeding screenings and water and in rolling. Such a surface will last longer without repairs and be an ideal surface for ordinary travel, both horse and motor vehicle, and one that will make as good a foundation for an asphaltic macadam surface as can be laid, when the increase of traffic warrants such construction.

Many of the old turnpikes that now form parts of the system of state highway routes will be maintained as water bound macadam roads until such time as the department is warranted by reason of increased traffic in laying a surface of other material. These turnpike roads were originally built and maintained for years with stone, broken by hand on the side of the road and then spread on the foundation prepared to receive them. No rollers were used, but the traffic that passed over the stone bound them together. It was by this method that Mr. McAdam reconstructed the old pike roads of England. In the counties where limestone is plentiful most of the 700 miles of toll roads in the state are to be found, many of such roads having an ideal surface, save for being dusty at times, such surface being maintained solely by the traffic, no rollers being used.

I believe that with so many opportunities to make use of water bound macadam economically and to advantage, the time has not arrived, and will not arrive for many years to

come, when that method of reconstructing public highways can be cast aside or relegated to the rear, as being of no value. It will be in use when some of the methods being experimented with today are cast aside.

CHAIRMAN PARKER: The next paper is entitled "Sheet Asphalt," and will be presented by Mr. George H. Norton, Deputy Engineer Commissioner of Buffalo, N. Y.

SHEET ASPHALT

By GEORGE H. NORTON
Deputy Engineer Commissioner of Buffalo, N. Y.

The specifications for good sheet asphalt pavement and the general procedure in laying it are too well standardized to warrant discussion within a 10-minute limit. This pavement has established its own place for use under various known conditions.

Within the past few years certain changes have occurred in traffic conditions which have largely eliminated one former standard road construction and it is well to look forward to the effect of these changes upon sheet asphalt through the introduction of heavy motor traffic. The truck with wheel load of 5,000 lbs. and upwards is now common on such pavements. For a pavement now laid which is to endure at least 20 years in the future, wheel loads of 10,000 lbs. or more may reasonably be expected. To meet these conditions there must be sufficient base to carry the load, sufficient tensile strength in the surface to withstand the tractive stresses and all possible adhesion or resistance between top and base to prevent relative movement.

The notes here presented are from experience in the maintenance of asphalt in Buffalo, N. Y.

The first sheet asphalt was there laid in 1878 and more or less has been laid every year since then. About five and one-half million yards have been laid of which about four and one-third million remain. The oldest in service is 9,000 yards laid in 1881 and 26,000 in 1882. About two million yards are 20 years old or more. An average life of at least 21 years is expected. Much of this pavement was laid on 6 ins. of natural cement concrete for a base. On some of these streets there are now appearing small circular depressions without rupture of surface. It is assumed that these are due to a breaking down of the base by heavy traffic loads. These will undoubtedly be followed by a corresponding break in the surface. Under this assumption of cause and effect, this base is not sufficient. This 6 ins. of natural cement concrete may be equal in carrying strength

to 4 or 5 ins. of Portland cement concrete, and such may therefore be assumed as of doubtful strength for a satisfactory foundation.

Many English cities are now using from 8 to 10 ins. and even 12 ins. of concrete for pavement base. This change has arisen from their earlier and more extensive experience with heavy motor traffic.

In the larger cities it is also necessary to route heavier loads up to 30 or 40 tons over some streets. At present we use a 6-in. Portland cement base on all pavements, but this will now be increased to 8 ins. on certain heavy traffic streets.

No base should be expected to hold over extended settlements in the underlying soil, but should not shear down over small depressions or soft places.

If we assume the circumference of one of the above noted pothole depressions as 30 ins. in a 6-in. base there would be 180 sq. ins. in shear. At the common assumption of 60 lbs. per sq. in. for concrete in shear, the safe working load would be 10,800 lbs., or a safe strength for motor truck loads but not for occasional loads of 15,000 or 20,000 lbs. per wheel.

With a satisfactory base provided, the strength of the top must be considered. With a motor developing 60 HP. at 10 ft. per second, the tractive effort on each of two wheels would be 1,650 lbs. If this be distributed over 8 ins. of wheel face there is a tensile stress of 200 lbs. per lin. in. of tire transferred to the pavement surface. If this be resisted by but one inch in depth of surface there is a stress of 200 lbs. per sq. in. within the asphalt surface. Will it always stand it? With a plastic top mixture there will undoubtedly be some surface displacement; with a hard mixture or in cold weather may not a thin top be ruptured? These are only offered as suggestive questions to those who have inclined toward a thin surface, or for the possible effect upon surface repairs where new material in a thin layer may not be thoroughly welded to the underlying material.

This question of surface movement under traffic naturally leads to consideration of the binder course. What is here said may be considered as a heresy in accepted asphalt practice. Buffalo has continued to use the open binder although the close binder is most generally recommended and used. We have continued the use of open binder after full and conservative consideration that there are yet sufficient sound theoretical reasons only to be set aside by proved results.

The main function of a binder course, as the name implies, is to connect the wearing surface with the base. Another function may be considered as that of protecting the surface from moisture in or upon the base. No material adhesion of any binder to a concrete base may be expected unless possibly through an applied paint course. With an open binder thoroughly rolled in a thin layer the sharp-edged pieces of stone must be forced into all inequalities of the concrete base and to a greater extent than if partially supported by a matrix. The topping when rolled on this open binder is forced down and into the interstices from ½ to ¾ in., thus forming an asphaltic concrete having much stability and integral with the topping.

An argument in favor of the close binder is that it resists disturbance during the laying of the top and may even be safely used for some light traffic. But this very advantage introduces the well known difficulty of making proper adhesion where the surfaces are smooth and have dust and increases the danger of cleavage or movement along the joint plane. For resistance against lateral forces there appears a material advantage for open binder into which the surface mixture may be so forced as to obtain positive bond.

Another possible advantage of the open binder is that it provides a small but distinct drainage course for water passing the surface at car tracks or through breaks.

The points here intended to be emphasized are that the standard sheet asphalt is a paving material having excellent resistance to wear when properly supported. This support must be not only vertical by provision of a stable base, but lateral by a sufficient thickness within itself to withstand tensile traffic stresses without tearing and having continuity to transfer these stresses to the base in the most direct manner.

Unless these supports are fully provided this pavement can not successfully meet the increased traffic requirements most evident for the future.

CHAIRMAN PARKER: Before you go ahead, gentlemen, I have got to put a proposition up to the meeting here and see what you have to say. I think you all want to have lunch before you go out in the automobiles; I am therefore going to suggest that the paper on "Unit Price and Lump Sum Contracts and Percentage Work," by H. C. Hill, Engineer, Lane Construction Co., and the discussion which is to follow it, be postponed until tomorrow, Friday morning. Now I would like to have your opinions or suggestions or a motion from some one to that effect.

[It was moved, seconded and voted that the suggestion of the chairman be carried out.

CHAIRMAN PARKER: Next is a paper on "Granite Block" by Mr. R. H. Gillespie, Chief Engineer of Highways of the Borough of the Bronx, New York City.

GRANITE BLOCK

By R. H. GILLESPIE
Chief Engineer of Sewers and Highways, Borough of the Bronx, New York, N. Y.

Stone in many forms has been used for pavements from the earliest times. The old Roman roads were constructed of solid masonry, in many cases as much as 3 ft. in depth, consisting of irregular shaped stones with interstices carefully filled with smaller stones, and the surface finished smooth and true. These roads were wasteful of material but remarkable for their durability and excessive cost.

The earliest pavements laid in this country were of the cobblestone variety, consisting of bank or water cobbles, varying from 4 to 9 ins. in diameter, embedded in earth, an attempt being made to lay the cobbles to a uniform surface. This style of pavement, while cheap, was remarkable for the noise produced by traffic passing over it, and it was also very severe on draft animals owing to the constant jar from the load hauled.

Following cobblestones, came what is known as the Belgian block. This type of pavement was a marked improvement over the cobblestone, and many miles of it were laid in New York City and vicinity. The blocks were usually of trap rock quarried along the west bank of the Hudson in the vicinity of the Palisades, and in sizes were from 6 to 7 ins. square on top, and about 7 ins. in depth, with a bottom dimension slightly less than the top. They were laid without foundation other than a sand bed and joints. While Belgian block was an improvement on its predecessor (the cobblestone), still it was open to many of the same objections. It was, like the cobble, very noisy and severe on animals on account of its roughness, and offered a poor foothold partly on account of the shape of the block and partly on account of the smooth glass-like surface of the individual blocks when worn by traffic.

Following the Belgian block, came the "specification" Belgian, which differed only in that the blocks were oblong, similar in shape to the present day granite blocks, and were open to the same objections as the square block, except that they afforded a better foothold for horses.

Next came the granite block, which combined the good qualities of the cobble and Belgian blocks, with desirable qualities of its own. On January 1, of this year, there existed in the City of New York 312 miles of granite block pavement. It is perhaps reasonable to believe that this type of pavement in its present improved form—and as it is likely to be further improved in the future—will increase rather than diminish in popularity. Its noisiness, which has been its chief objection in the past, is materially reduced in the improved block, and in view of the rapid increase in the use of rubber-tired vehicles, this objection, it is predicted, will soon entirely disappear. The earlier pavements of the granite block type in New York City and vicinity were laid on a sand foundation varying from 1½ to 3 ins. in depth; the blocks were from 8 to 12 ins. in length, 3½ to 4½ ins. in width, and 7 to 8 ins. in depth, so dressed as to lay joints not exceeding 1 in. Later specifications reduced the maximum width of joint to ¾ in. The pavement was then sanded, rammed and sanded again, and after all vertical joints were broomed full, the street was opened to traffic. In the early '90's a concrete foundation was provided for streets of particularly heavy traffic. The dimensions of the blocks, however, remained the same. On the concrete foundation was placed a sand cushion from 1 in. to 2 ins. in thickness, and the blocks laid with all vertical joints filled with hot tar and gravel.

Early in 1911 the engineers of the various boroughs of the city revised the specifications to provide for the so-called improved block. There was no concerted action, however, in this respect. Manhattan specified a block 7 to 11 ins. long, 3½ to 4½ ins. wide and 4¾ to 5¼ ins. deep, dressed to lay ⅜-in. joints. The Bronx block was 6 to 9 ins. long, 3½ to 4½ ins. wide, and 5 to 5½ ins. deep, dressed to lay ½-in. joints. The Brooklyn block did not agree with either, with the result that the quarrymen were at sea and hesitated to get out large quantities of blocks in advance of actual orders. During the winter of 1912, concerted action on the part of the quarrymen and engineers representing the different boroughs brought about a standard specification which fixed the size of the improved block at 6 to 10 ins. in length, 3½ to 4½ ins. in width, and 4¾ to 5¼ ins. in depth, and dressed to lay ½-in. joints.

Manhattan laid its first improved block pavement on Fourth Ave., between 8th and 23rd Sts.; the Bronx on Teasdale Place, between Boston Road and Cauldwell Ave., the former being a street of very heavy commercial traffic, the

latter a street of light traffic but with a 9.6 per cent. gradient. Each was laid under the specifications peculiar to the respective boroughs as to the size of blocks and dressing. The vertical joints of the Fourth Ave. pavement were filled with hot paving cement and coarse sand, and cost $3.55 per sq. yd. including foundation; the Teasdale Place pavement was filled with Portland cement grout mixed in proportion of one part cement and two parts Cow Bay sand, and cost $4.85 per sq. yd., including foundation. The high price on this contract was probably due to the small amount called for (725 sq. yds). During the season of 1912, large areas of this type of pavement were laid under the standard specifications for improved block. The reports for the year ending December 31, 1912, for Manhattan and the Bronx indicate these areas as follows:

	Sq. yds.	Miles.
Manhattan—Improved granite block	156,000	7.52
Bronx—Improved granite block	54,975	2.22
Manhattan—Special Imp. granite block........	108,000	4.17

the latter differing from the former in that the joints are ⅜-in. instead of ½-in. All the Bronx improved granite pavements have joints grouted with Portland cement mortar, and all those laid in Manhattan are laid with paving cement and sand. The average cost, including a 6-in. concrete base, in Manhattan has been about $4.50 per sq. yd., and in the Bronx $4.18 per sq. yd. Contracts are now in force or in preparation for extensive areas of this type of pavement.

Recently a granite pavement was laid in the Brooklyn Navy Yard similar to the Durax and Kleinpflaster block pavements of England and Germany. The blocks were manufactured in Salisbury, N. C., with an imported sett-making machine and were smooth and uniformly 2¾ by 3½ ins. head dimensions. On account of this uniformity in size, the laying in concentric circles or segments as practiced in Europe had to be abandoned, and the blocks laid in straight lines or in arcs or circles of long radii. The pavement was laid on concrete with a cushion of stone chips ½-in. in depth. The joints were filled with the same material and poured with hot paving pitch. This type of pavement has been used extensively in Europe and has given excellent results under heavy traffic conditions. Though it may be an economical pavement abroad owing to the lack of quarries furnishing suitable stone and the necessity of making use of small fragments that cannot be used for other purposes, as well as the low cost of labor, it is believed that in this country where there are many suitable quarries and where

labor is very costly and entirely inexperienced in laying this type of pavement, the materially higher cost, as compared with the cost of improved blocks as at present laid, would hardly seem justified.

The writer wishes to bring out in the paper the great economic value for repaving purposes of existing granite block pavements originally laid on a sand foundation. In 1908 the suggestion was made to the Bronx authorities as to the advisability of making use of the old granite blocks by splitting and redressing them. Strange to say, the person making this suggestion was a paving contractor largely interested in granite quarries. The scheme met with approval and a contract was gotten out for repaving Webster Avenue from 165th St. to 171st St., with the result that an excellent pavement was obtained at very low cost. There has been practically no maintenance cost since the contract was completed, and the pavement at the present time is in very satisfactory condition. The blocks laid on sand, under the old specifications, are in most cases fully up to the length specified; in fact, a considerable proportion run from 12 to 14 ins. in length and are rarely less than 7 ins. in depth. The splitting and dressing consists in breaking in two the blocks running in length from 11 ins. up, using the broken face as the head and dressing the ends and sides to lay ½-in. joints. The finished blocks are from 6½ to 8 ins. long, 3½ to 4½ ins. wide, and 5½ to 6½ ins. deep. Blocks shorter in length than 11 ins. are reheaded where necessary, dressed to lay the required joints, and as a rule are used along the street railway tracks. The splitting and dressing are done on the streets by cutters who receive about 1½ cts. for each redressed block, each man getting out from 450 to 600 blocks per 8-hour day, depending partly on his skill and speed and partly on the character of the granite and the condition of the blocks. As the blocks are dressed they are piled along the sidewalk until the concrete is in readiness for the pavement. The blocks are laid in the usual manner, in rows, at right angles to the curb line on a 6-in., 1:3:6 concrete foundation with a 1½-in. sand cushion. Up to November 15. of this year, 207,150 sq. yds. (or 7.96 miles) of this type of pavement had been laid in the Borough of the Bronx, all of it with vertical joints filled with Portland cement grout, at an average cost of $1.21 per sq. yd., exclusive of concrete base, as compared with an average cost of $3.20 per sq. yd., for new improved granite block, exclusive of foundation.

At the beginning of the present year there existed in the

Greater City old style granite blocks on a sand foundation, as follows:

	Sq. yds.		Miles.
Manhattan	406,075	or	18.6
Brooklyn	1,149,323	"	73.9
Bronx	683,835	"	28.3
Queens	277,800	"	25.0
Richmond	41,582	"	2.4
Total	2,558,615	"	148.2

This represents over 50,000,000 granite blocks, nearly all of which are suitable for redressing, and when so redressed and relaid, as above described, will produce pavements that for cleanliness, smoothness, adaptability to heavy traffic, and durability are practically equal to the new granite pavements laid under the present improved specifications and at considerably less than half the cost. During the past four years all the improved and redressed granite pavements in the Bronx have been laid with joints filled with Portland cement grout, while in Manhattan and the other boroughs they have been filled, for the most part, with paving cement or paving cement and gravel. The writer is of the opinion that under like conditions a thoroughly and well grouted granite pavement will give better results than one where paving cement and gravel are used. It is more easily cleaned, is apt to shed water more readily, is slightly smoother, and there is less tendency for the blocks to turtle-back. There is one temporary but serious objection, while it lasts, to the grouted pavements that should be noted; viz., the interference and inconvenience to business interests along the line of the street due to the time that the street must be kept free from traffic while waiting the setting of the grout. This time should be, under the most favorable conditions, not less than one week. Still it is quite practicable to pave one-half of a street at a time, and thus to some extent minimize this objection.

In conclusion, the writer ventures the opinion that for streets which are called upon to accommodate a large amount of heavy commercial traffic, the pavement of the granite block type (whether new or redressed, whether grouted or tarred), under the present specifications, will prove more economical and generally satisfactory than pavements of perhaps any other type on account of its adaptability to all grades, its non-slipperiness, its sanitariness and its durability. Its chief objection, noisiness, as stated before, is eliminated to some extent by the use of a smoother block, and, further by the advent and increasing use of rubber-tired motor vechicles for iron-shod horse-drawn vehicles.

The Inspection Trip

On the afternoon of Thursday, December 11, about two hundred of the delegates and guests at the convention were taken on an inspection trip over various roads and streets in and near Philadelphia. The trip was arranged by the Bureau of Highways and Street Cleaning of the Department of Public Works and was made in about forty automobiles furnished by the bureau.

Starting from the convention hall at Broad and Callowhill Sts., the route led over Broad and Spring Garden Sts. to the Park Drive, through Fairmount Park to Wayne Ave. and Lincoln Drive; thence northwesterly over McCallum St., Mermaid Lane, Cherokee St., Moreland Ave., Huron St., Willow Grove Ave., Seminole Ave., Chestnut Hill Ave. and Bethlehem Pike to Stenton Ave. From this point the route led in a generally easterly direction to the city line at Oak Lane; thence through various roads in Montgomery County to the city line at Ryers Ave. and Cottman St. From here the party passed over Cottman St. and Castor Road to the Bustleton Pike; thence to the service test roadway, extending from the junction of the Byberry and Bensalem Turnpike and the Bustleton Turnpike to the northerly city line, over the former thoroughfare.

The cars passed slowly over the 26 sections of the service test roadway and, making a short detour at the end, returned over the same route to the junction of Castor Road and Cottman St. Short stops were made along the service test roadway to allow those who so desired to examine the different pavements. At the side of each section the Bureau of Highways and Street Cleaning had erected signs giving the number, length and location of the section and the kind of pavement, together with a somewhat detailed description of its construction. Before starting, those taking the trip had also been provided with pamphlets describing the roadway and with sheets showing the itinerary of the trip and the kind of surface on each road and street passed over.

The return trip from the intersection of Cottman St. and Castor Road was made over Cottman St., Oxford Pike, Northeast Boulevard and Broad St. At the northeasterly end of the boulevard a stop was made to allow the delegates to inspect the work being done by the McNichol Paving & Construction Co. which holds the contract for work now in progress, which will cost approximately $1,000,000.

The detailed itinerary of the trip, together with the kinds of road and pavement passed over, was as follows:

From the First Regiment Armory, Broad and Callowhill

Sts., over Broad St., paved with asphalt in 1911, to Spring Garden St., and thence as follows:

Spring Garden St.—Asphalt, 1911.

Park Drive—Park entrance to Girard Ave. Bridge, Amiesite, 1911; Girard Ave. Bridge to Falls Bridge, Filbertine, 1911; Falls Bridge to Lincoln Drive, Bermudez asphalt, 1911.

Lincoln Drive—Filbertine, 1912.

McCallum St.—Lincoln Drive to point north of Ellett St., water bound macadam, 1912, surface treatment in 1913 with Tarvia "B;" Elliott St. to Allen's Lane, Filbertine, 1912; Allen's Lane to Gowan Ave., water bound macadam, 1912, surface treatment in 1913 with Tarvia "A;" Gowan Ave. to Cresheim Bridge, penetration Standard binder "B," 1911; Cresheim Bridge to Mermaid Lane, Filbertine, 1912.

Mermaid Lane—Filbertine, 1912.

Cherokee St.—Filbertine, 1912.

Moreland Ave.—Filbertine, 1912.

Huron St.—Filbertine, 1912.

Willow Grove Ave.—Huron St. to the Pennsylvania Railroad Bridge, Filbertine, 1912; Pennsylvania Railroad Bridge to Seminole Ave., water bound macadam, 1913, surface treatment in 1913 with Tarvia "B."

Seminole Ave.—Willow Grove Ave. to 150 ft. south of Gravers' Lane, Filbertine, 1912; 150 ft. south of Gravers Lane to Highland Ave., water bound macadam, 1912, surface treatment in 1913 with Tarvia "B;" Highland Ave. to 300 ft. north of Highland Ave., Filbertine, 1912; 300 ft. north of Highland Ave. to Chestnut Hill Ave., water bound macadam, 1912, surface treatment in 1913 with Tarvia "B."

Chestnut Hill Ave.—Seminole Ave. to Owens Lane, water bound macadam, 1912, surface treatment in 1913 with Tarvia "B;" Owens Lane to Bethlehem Pike, Filbertine, 1912.

Bethlehem Pike—Water bound macadam, 1912, surface treatment in 1913 with Ugite 1-C.

Stenton Ave.—Bethlehem Pike to Gravers' Lane, water bound macadam, 1912, surface treatment in 1913 with Ugite 1-C; Gravers' Lane to Cresheim Bridge, maintained by Cheltenham Township, old water bound macadam treated with Ugite; Cresheim Bridge to point 250 ft. south, water bound macadam laid in 1912, surface treatment in 1913 with Glutrin; 250 ft. south of Cresheim Bridge to Mt. Pleasant Ave., Filbertine, 1912; Mt. Pleasant Ave. to point 210 ft. south of Phil-Ellena St., Filbertine, 1913; 210 ft. south of Phil-Ellena St. to Washington Lane, old Tarvia penetration, 1909, surface treatment in 1913 with Tarvia "A;" Washington Lane to Haines St., Filbertine, 1909.

Haines St.—Stenton Ave. to Limekiln Pike, Filbertine, 1913; Limekiln Pike to 18th St., old water bound macadam, recently dug up for the installation of water pipes, under contract to be resurfaced with Filbertine; 18th St. to 15th St., Filbertine, 1913; 15th St. to York Road, water bound macadam, 1912, surface treatment in 1913 with Tarvia "A."

York Road—Filbertine, 1911.

Oak Road—Filbertine, 1911.

Cheltenham Ave.—Filbertine, 1913.

Oak Lane—Bermudez asphalt, mixing.

Cheltenham Road—Old water bound macadam.

Garfield Ave.—Old water bound macadam.

Ryers Ave.—Old water bound macadam, surface treatment in 1913 with asphaltic oil.

Cottman St.—Ryers Ave. to Philadelphia & Reading Railway, water bound macadam, 1913, surface treatment in 1913 with Tarvia "B;" Philadelphia & Reading Railway to Second St. Pike, bituminous pavement, Topeka specification, 1913; Second St. Pike to Castor Road, Filbertine, 1909.

Castor Road—Penetration, Texaco road asphalt, 1912; two sections of water bound macadam, 1912; surface treatment, 1913, Ugite 1-C.

Bustleton Pike—Castor Road to Pennypack Creek Bridge, old Tarvia penetration section, laid 1909, surface treatment in 1913 with Tarvia "A;" Pennypack Bridge to Welsh Road, old Tarvia penetration, 1910, under guarantee; Welsh Road to Byberry and Bensalem Turnpike (service test road), old Tarvia penetration, 1909, surface treatment in 1913 with Tarvia "A."

Service test roadway—26 sections, paved with different materials.

At the end of the service test roadway the party turned and went back over the service test roadway, Bustleton Pike and Castor Road to the intersection of Castor Road and Cottman St., thence, as follows:

Oxford Pike—Old water bound macadam.

Northeast Boulevard—Under construction under contract with the McNichol Paving & Construction Co. for the completion of same from 2d St. to Rhawn St.; contract amounting to $1,000,000. The boulevard is 300 ft. in width between building lines, with a central driveway of 60 ft. and two side driveways 34 ft. each. The central driveway is paved with a 30-ft. strip of bituminous pavement (Filbertine) and water bound macadam shoulders, with brick gutters. The side driveways are to be paved for their full width with bituminous pavement (Topeka specification) with brick gutters.

Thence over the Northeast Boulevard from Oxford Pike (Oxford Circle) to Broad St. (The portion of the boulevard from 2d St. to Broad St. was completed in 1910 with water bound macadam paving.)

Broad St.—Paved with asphalt for its entire length, laid at various times between 1900 and 1911, with the exception of a section from Silver St. to Cumberland St., which is paved with redressed granite blocks.

SIXTH SESSION

Thursday Evening, December 11

The sixth session of the convention was a public meeting and was held on Thursday evening, Dec. 11, in the Ball Room of the Bellevue-Stratford Hotel. It was called to order shortly after 8 o'clock by J. C. McAvoy of the Entertainment Committee, who introduced as the permanent chairman Director Morris L. Cooke of the Philadelphia Department of Public Works.

Before introducing the first speaker of the evening, Director Cooke spoke briefly on the special significance of the convention to Philadelphia and to the state of Pennsylvania. He said that there were evidences from all sides of a deep determination on the part of the people to have good roads—good roads were essential from the economic standpoint and from the standpoint of the enjoyment of the people, and they were going to have them. We could go through a period of chaos if we liked, he said, but it seemed that through such gatherings as the convention chaos might be by-passed and the work carried out in such a way that the people would get a dollar's worth of value for each dollar expended. He expressed the belief that highway engineers were emerging from the period of uncertainty, and said that it behooved us to see that the profession of highway engineering was fostered in every way and to take an intelligent interest in the subject. He then introduced as the first speaker T. R. McDowell, President of the Chester County (Pa.) Supervisors' Association.

In opening his address, Mr. McDowell said that it would seem unnecessary in a gathering such as he was addressing to lay emphasis on the importance of good roads, but that, as in many other important questions, the desired results could be obtained only by a continued insistence upon the advantages of road improvement. He said that there was only one side to the question and that what difference of opinion existed was as to the means of accomplishing the betterment of the public highways. As an example of this

he referred to the recent vote on issuing bonds in Pennsylvania, expressing the belief that the defeat of the proposition was due not to opposition to the proposition that good roads were needed but rather to a difference of opinion as to the wisdom of involving the commonwealth in debt.

Mr. McDowell held that the whole status of the road question had materially changed within the past few years, and that while formerly it was a matter of improving the roads leading from the home to the store, to the postoffice and to the church it had now grown to be broader in its scope. In support of that belief, he cited the Pacific Highway, the Quebec-Miami Highway and other roads of a like nature. He also referred to the difference in conditions in different parts of the country, but contended that these differences did not render the question hopeless. He said that the several states acting as units in a great whole must work out their several parts of the problem. He also referred to the matter of maintenance, saying that we were learning what we might have learned fifteen years ago from the railroads—to keep watch over our roads.

After the close of Mr. McDowell's address, Chairman Cooke introduced as the next speaker Mayor Rudolph Blankenburg of Philadelphia.

Mayor Blankenburg expressed his disappointment at having been unable to be present at Philadelphia when the convention opened to extend to the delegates a welcome on behalf of the city. He referred to the fact that the delegates came from practically all of the states in the Union and said that he did not know that anything had happened in Philadelphia since he had assumed office that was more important to the city and to the nation than the discussion of the questions which were before the convention. He said that in Germany the people had had to fight to get even passable roads from the home of the farmer to the church and to the store, but that good roads were finally obtained and that Germany at present was far ahead of this country in that respect. That this was so he attributed to the lack of concerted action in this country. "Each village, each town, each county and each state," he said, "has done a little in its own small way, but they have not worked in unison. Now, if they work in unison, I predict that the middle-aged men in this audience will live long enough to see the roads in this country in as good condition as they are in England or on the continent of Europe."

In referring to the proposal that the government spend large amounts of money in road building, he said that he

did not know that money could be spent for any better purpose. He expressed disapproval of the expenditure of money for war, and said that if the money could be spent for the improvement of the roads it would do a great deal of good.

In closing he said that if the chief magistrates of the cities, the governors of the states, the Legislatures and similar forces could be combined we could set the world an example not only of the republican form of government but also an example in providing what is best for the citizens in helping every part of the country and by so doing helping the whole.

In introducing the next speaker, Representative Dorsey W. Shackleford, of Missouri, Chairman Cooke said that it was generally realized among those who had given any thought to the matter of administration that waste and inefficiency resulted more from a lack of coordination than from a lack of knowledge or through intention. He illustrated the lack of coordination by the frequent absence of connection between good roads in the city and in the country, and said that if we were to make progress in road building such haphazard work must stop. He said that he, for one, was not afraid of having the national government take a strong and leading part in the matter of road building as in other matters. Congressman Shackleford was one, he said, who had given a great deal of attention to the subject and who, as Chairman of the Roads Committee of the House of Representatives, had done much to bring about government participation in road building.

After expressing his pleasure at the privilege of speaking before the congress, Congressman Shackleford confined his remarks to an argument for federal aid, urging especially the construction of market roads—roads enabling the farmer to bring his products to the markets—instead of roads for long distance automobile traffic. He argued that the long, continuous roads were not needed for commercial automobile traffic, that such a method of transportation would not replace the railroads, and that money expended for road building should be devoted to the building of those roads over which the food and other products of the nation had to be hauled. He closed with an invitation to those identified with the work of building roads to go to Washington and appear before the committee and give to it the benefit of the information they had.

Chairman Cooke then introduced as the next speaker President Samuel Hill of the American Road Builders'

Association, referring to him as a man who had done a great work in this country in popularizing the road movement.

President Hill, who was the last speaker of the evening, delivered a lecture upon the roads of Europe and America, which he illustrated by a large number of lantern slides. Among the views shown were a series of slides showing convict road work in the state of Washington, a series showing the work done on Mr. Hill's estate at Maryhill, Wash., and a series of views along the Columbia River. In the course of his address, President Hill made especial reference to the matter of convict labor and to the Pacific Highway Association and its work.

The meeting was attended by an audience, estimated at over a thousand, that filled the main floor and part of the balcony in the hotel ballroom.

SEVENTH SESSION

Friday Forenoon, December 12

PRESIDENT HILL: I expected Mr. Harold Parker, who presided yesterday afternoon, to be present and finish the discussion this morning, but he is not yet here, so we will take up the program as it is for this morning. Many of the men now in attendance are outside on the Committee on Resolutions, but they are within call and it will not be long before our seats will fill up. This is the seventh session. The subject is Construction, continued, and the first paper will be read by Prevost Hubbard, in charge of the Division of Roads and Pavements, Institute of Industrial Research, Washington, D. C., the title being "The Testing of Materials for Road and Street Construction." Is Mr. Hubbard in the room?

If Mr. Hubbard is not present, Mr. Cooley—not Mr. Hooley—will say a few words. Mr. Cooley is a very good road builder; I know that because I started him in the work thirty years ago myself. Gentlemen, Mr. Cooley. (Applause.)

GEO. W. COOLEY (State Engineer of Minnesota): I think the Chairman is wrong; I think it is I who started him. My impression is that Mr. Hill and I were among the pioneers in road building in Minnesota, but generally when we first got together on the road proposition it was surveys.

It was my misfortune not to be here yesterday at the time my paper was read on gravel roads, and I won't touch on that subject, but I do want to say this: A portion of our program relates to the question of maintenance, and you can

see there is nothing more important in the whole road proposition than the proposition of the thorough maintenance of our roads. It doesn't make any difference whether you build a concrete road, a brick road, a gravel road or any other kind of a road, a road is no good unless it is provided with proper maintenance.

We are building, in Minnesota, a large and continually increasing mileage of earth roads. I think the earth road, when in proper condition and when conditions are favorable, is about the best proposition we have for road construction and travel. Now, the system of maintenance we adopted in the state of Minnesota is modeled after the European system, with which you are all familiar, and that is the system of road patrols. We provide a patrolman for each five or six miles of our highways—common earth roads. We also make provisions for the depositing of suitable material alongside of the road for maintenance and repair, and we equip each man with a rake, shovel, hoe and wheelbarrow and all that sort of equipment for repairing the road and pay him $50 or $60 a month. We find that on our earth roads we can keep the surface in good condition at an expense of $50 or $60 per mile per year and always have the roads in good condition. These men are located five or six miles apart, and the automobilists have joined with us in keeping the roads in repair by notifying the road patrolman of the condition of the highways in that section for which the patrolman is responsible. For instance, if an automobilist passes along a road and finds that a rock is sticking up, he will notify the patrolman and the patrolman will take immediate steps to remedy it. So we remedy the defects in the roads as fast as discovered and feel satisfied that an ordinary earth road can be kept in splendid condition for the ordinary use of the road at least 300 days in the year. That is about the best we can do for that class of road.

Now, the road system we have adopted is largely a gravel system. We build gravel roads that cost about $1,500 or $2,500 a mile, a few macadam roads and some concrete roads, but no brick roads. We expect in the course of a few years to work into a more expensive system of highways, but at present we are depending very largely on earth roads.

As stated last night by Mr. Shackleford, we have about 2,000,000 miles of earth roads in the country. For the next 15, 20, 25 or perhaps 50 years a very large percentage of our mileage will be earth roads, and those are the ones we have got to attend to to protect the best interests of the agricultural community. I think that is about all I have to say.

PRESIDENT HILL: Gentlemen, I find that Mr. Parker did not finish his program yesterday afternoon. The next question to be discussed is "Unit Price and Lump Sum Contracts and Percentage Work," and the paper will be read by Mr. H. C. Hill, Engineer of the Lane Construction Corporation, Meriden, Conn. Is Mr. Hill present? I have never met Mr. Hill before, but he is all right because he's got the right kind of a name. (Laughter and applause.)

UNIT PRICE AND LUMP SUM CONTRACTS AND PERCENTAGE WORK

By H. C HILL
Engineer, Lane Construction Corporation, Meriden, Conn.

The subject of this paper, unit price and lump sum and percentage work, readily divides itself into a consideration of percentage vs. contract work and unit price vs. lump sum contracts. None of these methods is perfect and while under certain conditions one may be better than another, this paper will attempt to prove that in a great majority of cases contract work on a unit price basis is the correct method.

Percentage work is nothing more than day labor, as far as the cost of manual work is concerned, and differs in total cost only in that there is at the start an organization with a certain knowledge of how the work should be laid out and executed and a man or firm whose reputation for not doing work at an excessive cost is at stake.

Contract work has everything that percentage work has and something in addition, namely, an incentive, which constantly spurs every man, to a more or less degree, depending upon his nature, to do the work set before him in the most economical manner and with the least expenditure of energy. Some will say that this is too true and leads in a few cases to poor work. If this is so, it is not the fault of the method, but the fault of those doing the work, more particularly those having supervision, for it is possible to eliminate entirely those contractors who desire only to make as large a profit as possible irrespective of the class of work done—and it has been done.

An attempt has been made to instill "incentive" into percentage work by establishing a price on each unit of work and paying a bonus on a sliding scale if the work is done at a cost less than that first agreed upon. This is a very delusive point and those familiar with the variable factor in cost data will readily see the futility of it. Furthermore, it will not take much of a mathematician to figure that it is

the percentage that gives the contractor his profit and not the bonus, unless the agreed price is considerably higher than the actual cost should be. It being true, then, that percentage work tends to increase the cost of the work there remains the question of under what method of payment contract work shall be done.

In comparing the advantages and disadvantages of lump sum and unit price contracts it is possible to consider them under two heads; namely, the engineering feature and the moral aspect.

So much has been written and said on the former that nearly all of you are familiar with that phase of the question, so under this head only that point which has the greatest bearing will be considered; namely, the relative cost of the two methods. Let us, then, consider the engineering feature first and the moral aspect second, as the latter is the one which needs more attention at the present time.

The point upon which the advocates of the lump sum method lay the greatest stress is that the cost of work is reduced by having the engineering charges a minimum and those of this opinion are wont to tell how much cheaper work is done, basing their comparisons on an average cost—as in highway construction the average cost per mile—instead of basing the comparison upon the actual amount of material moved or used. The truth or falsity of this statement is not subject to any specific proof, for it is impossible to have the same piece of work done using both methods, but is subject to proof in a general way. A very close approximation might be obtained if desired by procuring bids for the same piece of work on each method, then after the completion of the work comparing the average of all the lump sum proposals with the average total of the unit price proposals, using, however, as a basis for the latter, the actual unit quantities as shown by a final estimate, not the bidding schedule quantities. This is, perhaps more theoretical than practicable, but what in the writer's mind is a satisfactory proof that under lump sum contracts the work costs more is the following: No reliable experienced contractor will bid as low on a lump sum proposal as he will if the work is to be let on a unit price proposal. This is a definite statement but one which a majority of contractors will agree to, and for this reason: Contract work in any form contains certain factors, the exact nature of which it is impossible to definitely determine until after they are encountered, and every contract, except it be a percentage contract, must

necessarily be more or less of a gamble. Therefore, no contractor overlooks this factor and you can rest assured that the larger the risk the higher the bid. This element of risk is less on a unit price contract than on a lump sum, for under the former should a certain class of work increase over the estimate the contractor gets a corresponding increase in pay and should less work be done he gets a corresponding decrease in pay. Under the lump sum method such changes have no effect upon the amount of money received by the contractor for doing the work.

In some cases under lump sum bids estimates for the various quantities are prepared but the general practice is for the bidder to ascertain for himself, either by his own engineer or by guess based upon general knowledge. Even in cases where careful estimates are prepared the final quantities are not the same as those upon which the bid was made out, therefore as far as payment is concerned under this method, estimates are of no value. The fact, however, that there is a variance between the preliminary and final estimates is not the fault of an engineer for it is impossible to determine accurately the exact quantities until the work is completed.

The theory of the unit price method is a very simple and just one and expressed in a few words conveys this idea: The contractor is to be paid for just what he does and to do just what he gets paid for. Nothing could be more equitable than this. However, like everything else, it has its imperfections, but not of a very serious nature. Its weakness lies not in itself, but in the hands of inexperienced men, incapable through ignorance of properly preparing unit quantities. This weakness causes what is known as unbalanced bidding and consists of bidding high on items, the estimate of quantities of which in a contractor's judgment is lower than will be used, or vice versa, and so regulating his bid on these items that he will lower his total bid on one hand and at the same time increase the aggregate amount he will receive for doing the work. This results sometimes in putting an engineer in an embarrassing position and has, therefore, caused some to condemn this method. Before taking this stand they should ask themselves if an unbalanced bid is any worse than an unbalanced bidding schedule prepared by engineers and if what criticism of unit price contract method there is, is not primarily due to those who make the estimates and not to the contractors. If engineers were as careful not to leave any loopholes in preparing estimates for contractors to bid on as they are in making out specifications

for them to do the work by, unbalanced bidding would become almost an unknown quantity.

Another advantage of having work done by unit prices is that it enables changes to be made while the work is in progress with the least possible chance of any dispute and as a rule at less cost than by the lump sum method. Oftentimes such changes are to the disadvantage of the contractor but the majority of them realize that the changes are necessary for the proper execution of the work and so much more satisfactory to them are unit prices that they prefer to do work by this method and willingly submit to such additions or deductions as may be found necessary while the work is in progress. While of course under the lump sum method changes are possible, so much is involved that only as the last resort is any change made. This is unfortunate for I venture to say that no work was ever undertaken but that during its construction it was possible to make some alteration that would not only improve the work but also in many cases save hundreds of dollars—even more than the total engineering expense would amount to by having the work done on a unit price basis.

I have never been able to see but one object in lump sum contracts and that is, that some one was looking for a chance to catch a sucker—and in most cases one is caught. However, this monetary advantage, for that is what it is, is only temporary, for sooner or later the fortunate one becomes the unfortunate.

Great as are the advantages of the unit price contracts viewed from the engineering standpoint, much greater are they when looked at from the moral standpoint, which cannot but have a beneficial effect upon the class of work done. There is no contractor earning a living by his work, but whose principal object is to make money. The word "principal" is used instead of "first" to differentiate. His first object should be to do as good work as is intended by the specifications. Careful examination of the successful contractors and those who remain so year after year will show that good work is their first object, while as a rule it is not so of those who fail. Therefore it is the duty of those engineers in charge of work to assist in every way possible to have this thought uppermost in the contractor's mind. At first this might seem to indicate a weakness on the part of contractors but after careful consideration nobody should look at it in this light and for this reason: It is the nature of many people not to do the task set before them in as careful, thorough and complete a manner as it should be

done in. In this respect contractors, and more particularily their employees, are not unlike others; therefore, any method of payment that will remove the temptation not to do good work or make it an object to do work in a careful, thorough and complete manner will not only insure the doing of all work but also its being done in a better manner. It needs only a superficial examination of a lump sum contract to see that not only is the incentive to do faithful work absent but there is also a premium for not doing it.

Contracting today is a business representing investments of millions of dollars, in which men of honesty, ability and training predominate, whose desires are to make a fair profit on their investment and to do good work, so that whenever work is to be done near where previously they have worked their return will be welcomed by the people of that community.

Engineering today is a profession which is fast receiving from the public that credit which it should have received so many years ago, and likewise is made up of capable and honest men desiring to give their employers the best there is in them. No better means of proving these statements exists than by means of the business in which the most of us present are engaged, namely, highway construction, for our work is constantly before the eyes of the public. The engineer is no more responsible to the public than is the contractor, for payment for the service of both comes from the same source. Therefore it should be the duty of engineers and contractors to work together to this end, and only by a unit price contract rather than lump sum can the first step in this direction be taken, for by the former, payment is made for just so much work as is done and no more and at the same time an incentive is always at hand to do faithful work, while under the latter, payment is not equitable nor is there the incentive to do faithful work.

PRESIDENT HILL: I am sure, gentlemen, you all enjoyed the very clear and comprehensive presentation of the subject given by Mr. Hill. The discussion will be opened by Mr. J. J. Ryan, Secretary of the New York Road Builders' Association. Gentlemen, I take pleasure in presenting to you Mr. J. J. Ryan. (Applause.)

J. J. RYAN (Secretary, New York Road Builders' Association): Mr. Chairman and Gentlemen: During Mr. Hill's clever handling of the subject of percentage work vs. contract work and unit prices vs. lump sum contract I have been saying "Amen, Amen," to all his statements, so that

I fear my few words will be nothing more than a weak continuation of the subject.

My opinions will be from a contractor's standpoint, which point of view is natural for me to take, inasmuch as I am associated with contractors, and have become inoculated with their many virtues and their very few sins. Although at the present time the New York papers want to lead you to believe that the New York state highway contractors are beginning to wear stripes, and to practice the lock-step, I want to say right here that good work is being done in New York state where we are working under an item price contract basis, and it has not been entirely the fault of the contractors that some poor results have been obtained in highway construction—some responsibility should be placed upon the engineers who specified the poor types of roads. Where a type of road is specified, no one remembers the name of the engineer; but, if this road turns out to be a poor job, then everybody jumps upon the contractor, as he is the only one whose name is connected with the work.

There are two things that won't mix—an efficient engineer and a dishonest contractor. If the corporations and state departments provide capable engineers, there will be less cause for investigation. It is now open season on contractors, everybody is shooting at them. Investigation has become a national disease; the slogan is, "Investigate everybody but yourself." The malady is now in its most aggravated form, so that the public readily believes anything that is stated. Insinuations are taken as facts and threats of revelations as convictions. We are in hope that at some time in the near future all this strife will come to an end and we will once more get down to the business of building roads, not tearing up roads.

Speaking of the difference between percentage contracts and contract work, I think that while there are certain times when the percentage basis of payment will appeal to the contractor (and I know that there are many reliable contractors engaged in doing work on a percentage basis and that some of these contractors, on account of their good reputations, have made connections with large corporations); yet I believe that a real, live, competent, pushing contractor likes to get a reward for his own good qualities, not on a percentage basis.

Sometimes when a contractor wants a sandwich job, that is, one that will tide him over until some new work shows up, or a small contract where supervision expenses will be

light, then percentage work may appeal; but for the most part I believe contractors in general would prefer to do work under any other basis than the percentage payment.

This brings us to the question of whether this work should be done by unit prices or by the lump sum bid. The unit price contract is about the only businesslike way of doing work. Contracting is a business; why not put it on a business basis? Efficiency is founded on cost data, and cost data can only be followed by figuring on item cost. Now, your experienced and capable contractor wants to be paid for his initiative, his originality, his executive abilities, his efficient organization and up-to-date plant. If by these he is able to figure on doing work for certain prices, then he wants to do it on a business basis when compensation will come to him in the same ratio as his capabilities are extended. Why should a contractor conduct his business in a different manner from the manufacturer or merchant? They figure on the item price, and in this way the producer, the seller and the buyer are all placed on the same fair basis. The contractor is a producer and seller, and with certain basic prices should be able to figure for what he can produce certain things. The owner or the builder, whoever it may be, is in this way assured, after prices are agreed upon, that the contractor or the producer will be paid only for what has been done.

Lump sum contracts are so uncertain that they are bound to generate a disregard for specifications and moral obligations. Rather do they lead the contractor's organization to do as little as it can in order to get through with the job. Lump sum contracts at their best are a gamble; and why inject gambling into contract work? At the present time there are enough uncertainties in connection with this work without loading it down with any more hazards. The fact that the surveys and estimates are hasty and inaccurate ought to be a danger sign to any contractor intending to bid on a lump sum contract, as this bidding is like buying a pig in a bag. There are generally two parties to a gamble —the gambler and the "fall guy." One time it is the gambler who wins, rarely the fall guy; someone is sure to be stuck.

Some engineers may state that the lump sum contract can be brought down to a basis where these uncertainties are to a great extent eliminated; but, if this is done, it is by a preliminary survey that will be so thorough and so exhaustive that when the estimates are made on the contract it will become nothing more than an item priced contract under a different name.

We believe that under the present system of awarding contracts in the state of New York both the state and the contractor are placed on a better basis; and we would dislike to see any change, feeling that when both parties to the contract have the item price basis of payment disagreements and dissatisfaction are reduced to a minimum.

PRESIDENT HILL: To you gentlemen who haven't got a dictionary with you, I will explain that the word "fall guy" means "sucker." (Laughter.)

Now the next speaker on the program was to have been our friend C. A. Kenyon, whom we all like. He is ill, and could not come, but he said he sent a man who can talk better than he can. I find that Indiana men can talk; I lived there a while myself. I take pleasure in presenting Mr. Duffey. (Applause.)

L. W. DUFFEY (Indianapolis, Ind.): I fear, after listening to our friend Shackleford address the meeting last night, I am in the wrong pew. I did not hear him make any mention of delegates from state or civic organizations, he merely referred to the "honk, honk" man, at least in Washington, and he made reference to the engineers and road contractors and machinery manufacturers of the country and the idle rich, and I don't think it is proper for me to sit here in a spirit of idleness and hear the name of my fair state of Indiana called without making some response. I am not prepared, however, to enter into any discussion; it is out of my line; contracting and road building is a thing I am interested in but about which I am not so very well informed.

But I do want to say, for Mr. Kenyon, that in Indiana we have a great deal of highway warfare as well as commercial warfare. We, in Indiana, are very much in arrears on good roads work, and when I hear you state highway commissioners, you engineers, stand here and give your comprehensive accounts of your operations and activities in your various states, I feel very much humiliated to think that we, in Indiana, have never known of such a thing as a state highway commission.

Our "highway commission" consists at this time, of 1,017 units and will continue so until the first day of January. These 1,017 units are the supervisors who represent the various townships in the counties of the state. Now, we have succeeded in transferring the power from those supervisors who manipulated, to our disgrace, the much needed road tax funds and entered credits against the tax receipts and would give them without any consideration other than the political friendship of the man who sought the credit. Now, we

have installed the county superintendency and the appointments are being made all over Indiana at this time.

But in Indiana we have the good roads idea in mind and we are going to keep on in this work until we get results. Indiana is one of the foremost agricultural states in the Union, and therefore needs a system of highways.

I favor, and Mr. Kenyon directed that I should voice the sentiment of the state by saying that we, in Indiana, favor the utilization of convict labor for the improvement of highways and oppose the exception taken by the National Board of Charities when they claim that it would be humiliating to the public in general to see the convicts at work on our highways. It is useless for me to discuss the various phases of road building. It would be far easier for me to take some man out on an interurban ride in Indiana and convince him of the value of some good farm within thirty or forty miles of those great skyscrapers of ours. We assure you that the democratic party, which is in power in Indiana and well represented in Washington, is pledged to highway legislation, and when we find some plan more suitable than Mr. Shackleford's plan—which provides for getting no sort of return for the material applied to the road and provides for nothing except the overhead expense—we are for you on any good roads legislation. I am more than gratified, on behalf of the Indianapolis Chamber of Commerce and on behalf of the state of Indiana, to observe the very wonderful progress made by the American Road Builders' Association. And I predict that when this government of ours shall have completed a system of highways connecting up all the capitals of our various states with the national capital, the government will be more than repaid, and that the roads will have a wonderful bearing on the social and industrial life of our state. Gentlemen, I thank you. (Applause.)

PRESIDENT HILL: The discussion was to have been taken up next by Mr. J. T. Gephart, Jr., Assistant Engineer of the State Highway Department of Pennsylvania. Mr. Gephart not being present, I will call upon the next speaker, Mr. John W. Davitt, a contractor, of Troy, N. Y., and this discussion will close yesterday's work. Mr. Davitt is ill and cannot be here, Mr. Myers tells me, and that closes yesterday's work and brings us down to our program this morning, and the next paper, the first paper this morning, is by Prevost Hubbard, who is in charge of the Division of Roads and Pavements, Institute of Industrial Research, Washington, D. C.

THE TESTING OF MATERIALS FOR ROAD AND STREET CONSTRUCTION

By PREVOST HUBBARD

Chemist in Charge, Division of Roads and Pavements, Institute of Industrial Research

The testing of materials for road and street construction is such a comprehensive subject that for an opening paper, which must be presented in a necessarily brief time limit, the author has thought it advisable to confine his remarks to certain fundamental principles rather than to attempt to discuss in detail any particular tests. For a number of reasons, bituminous materials are receiving more general attention than perhaps any others used in the construction and maintenance of highways. It is to this class of materials that the following comments are particularly intended to apply, although most of the principles enumerated are common to all.

For reasons that are not clearly apparent, the fundamentals of testing, in so far as they relate to the practical utilization of tests, have in many cases been overlooked by testing engineers and chemists in connection with bituminous road and paving materials. Disregard of these principles has undoubtedly created more confusion and misunderstanding on the part of highway engineers and contractors than any other one cause.

As applied to materials of construction, tests of both chemical and physical properties serve two main purposes: 1, as a matter of investigation, they constitute a record of the characteristics of the material examined; 2, when considered in connection with the behavior of a material in use, they serve as a guide for the selection of such material for future use.

In the matter of investigation it is often highly desirable that the greatest possible number and varieties of tests be applied to a material of construction, as by this means the most complete record of its characteristics are obtained. After considerable data of this sort have been secured on many lots of the same material, it is not as a rule necessary to make use of all of these tests in selecting such material for future use. Certain inherent and peculiar characteristics as determined by tests are, however, of value in the matter of selection, and such characteristics, when governed by quantitative limits, are made the basis of specifications for that material.

The ultimate utilization of tests for the purpose of selecting material for a given use makes it necessary that (1) the test

limits adopted shall specifically define the material, and (2) that the material thus defined shall have previously proved satisfactory for that particular use.

For some classes of material these points are not difficult to cover. In the case of bituminous materials, however, the matter is complicated by the numerous varieties or types of bitumen in common use, and the overlapping characteristics of various grades of these different types. The interpretation of tests in general is therefore no simple matter, and numerous misconceptions of the value of certain tests are prevalent. Standards of more or less established test values have been thrown into question by the introduction of new types of bituminous materials which, while similar to or identical in many respects with other better known materials, yet differ from them materially in certain physical or chemical properties. This has made it necessary to either modify old standards or to create new standards to be used specifically for the new materials introduced. It is the author's opinion that the latter method is in general to be preferred for reasons that will appear later.

The individual tests required by specifications for bituminous road and paving materials may serve one or more of the three following purposes:

(1) They may directly indicate the suitability for a given use of the material specified.

(2) They may serve as a means of identifying the source of a material or even the material itself.

(3) They may serve to control uniformity in the preparation or manufacture of a material.

The first of these purposes is undoubtedly the most important and is usually the only one considered by the lay mind. In the case of bituminous materials, this purpose is only partly accomplished by a comparatively few tests. As examples, may be mentioned tests of consistency, such as the penetration test, the float test and the test for viscosity. Such tests can only be of maximum value, however, when applied to a specific type of bituminous material and when considered in connection with other tests, which, by themselves, may not directly indicate suitability. Thus, for a certain type of bituminous concrete pavement the proper penetration limits at 25° C. for a California asphalt may lie between 7.0 and 9.0 millimeters, while the proper penetration limits for a fluxed Bermudez asphalt to be used in exactly the same type of pavement and under the same conditions, may be entirely different, say from 14.0 to 16.0 millimeters. It is evident that to attempt to cover the penetration limits for both ma-

terials under one specification would be useless. In the first place, such test limits as 7.0 to 16.0 millimeters are so wide as to insure but little uniformity in different lots of the same material; and in the second place, an entirely unsuitable material of one class might be supplied under the maximum test limit of the other class. The fallacy of blanket specifications, which have already been advocated to a considerable extent, is thus easily demonstrated.

If a penetration test is essential under the conditions just mentioned, it is apparent that recourse must be had to separate type specifications; and if this is so the specifications must contain either tests or test limits which will describe certain peculiarities of the type specified, that are not common to other types. In many cases this cannot be done by means of a single test and two or more such tests will be required.

This brings us to a consideration of the second purpose previously mentioned, i. e., the use of tests as a means of identification. There are a number of such tests, among which may be mentioned specific gravity, melting point, solubility in carbon disulphide, fixed carbon, etc. So far as the usual test records are concerned, the specific gravity of a bituminous road or paving material is one of the most important characteristics used to determine its identity, and this is particularly true if its specific gravity is considered in connection with the consistency of the material and sometimes its solubility in carbon disulphide. Thus a bituminous material with a specific gravity of 0.99 and penetration of 7.0 millimeters at 25° C. must be a blown product. Fluid consistency and high specific gravity, say 1.25, in a tar serves to identify it as a coal tar, and the identification is strengthened if its solubility in carbon disulphide is low, say 75 per cent. Numerous other examples of a similar nature might be cited and a treatise might be written upon the value of tests by themselves and in relation to other tests as a means of identifying bituminous materials.

High fixed carbon in most asphalt cements produced from Mexican petroleums is a distinguishing characteristic. Relatively low fixed carbon in good asphalt cements of the same consistency produced from California petroleums, serve to differentiate them from the Mexican products. Here, again, the necessity or desirability of different test limits is apparent, for if the amount of fixed carbon yielded by a California asphalt cement was as high as the 16 per cent. often found in Mexican asphalt cements, indications would point very strongly to injury of the former due to excessive

temperatures having been employed in the process of manufacture.

This leads us into the third purpose for which tests may be made to serve—control of uniformity in the preparation or manufacture of a material. Among such tests may be mentioned those for determining flash point, loss by volatilization, distillation, solubility in given grades of paraffin naphthas and solubility in carbon tetrachloride. Practically all of the other tests previously enumerated may also be made to serve this end. No one by itself will, however, necessarily accomplish this purpose, no matter how close the test limits are drawn. This is mainly due to the fact that products of innumerably varied and complex characteristics may be produced from a given crude material by modifying the methods of manufacture.

Thus, by direct distillation of a given crude petroleum, an asphalt cement of 10.0 millimeters penetration can perhaps only be produced by the removal of a considerable amount of distillate and the application of comparatively high temperature. If distillation is discontinued in an intermediate stage, however, and the blowing process employed, an asphalt cement of the same penetration may be produced with the removal of much less distillate and the application of a lower maximum temperature. In the second case, the resulting product, while of the same consistency as the first, may have a lower specific gravity, a higher melting point, a greater penetration at low temperature, and a less penetration at high temperature. Other properties such as fixed carbon, naphtha soluble bitumen, loss by volatilization, etc., may also be different. In such cases, control or assurance of uniformity in different lots of material must depend upon a number of tests, the interrelation of which is clearly understood, and for which suitable limits are specified.

In the preparation or interpretation of any specifications for bituminous road or paving materials, an appreciation of the interrelation of tests and test limits is as necessary as an understanding of the individual significance of the tests themselves, and yet those who should be most familiar with such matters often fail to consider the possible relation which a given test may bear to others with which it is associated in specifications. The interrelation of tests and test limits is something which the layman may not readily comprehend, and this has often resulted in his innocent acceptance and enforcement of unjustly discriminative specifications prepared or suggested by those who have an object to attain.

In the author's opinion, discriminative tests and specifica-

tions are perfectly proper and often desirable, if used in the right manner. They are, in fact, necessary to use, unless a more or less valueless blanket specification is adopted. When so used, however, their significance should be clearly apparent and they should not be put forward as open specifications.

When a given type of bituminous material has a single characteristic property which distinguishes it from other types, test limitations of this property may be so drawn as to make a specification discriminative. The status of such specifications is not usually difficult to ascertain. Discrimination is, however, sometimes secured by the use of a combination of two or more test limitations, the significance of which is only apparent under the close scrutiny of one who has an intimate and comprehensive knowledge of all types of bituminous materials. Specifications of this class may, as a whole, absolutely eliminate competition, although no single clause in the specifications could be criticised from this standpoint.

If competition is eliminated by a single specification, as is sometimes advisable or even necessary, in order to insure a satisfactory product, it may often be restored by the use of two or more specifications which will serve as alternatives. When this is done, two or more types of bituminous materials will be specified, which are of equivalent value in so far as their suitability for a given use is concerned. Thus while different test limitations and sometimes different properties are covered by the different specifications, each particular combination of test limitations and properties, constituting a given specification, will be considered as an equivalent..

From the foregoing discussion, it must be evident that the preparation of specifications for bituminous road and paving materials is often a complicated matter and should only be undertaken by one who has thoroughly familiarized himself with the origin and manufacture or preparation of all types of bituminous materials as well as with their physical and chemical characteristics. It is the author's experience that comparatively few highway engineers in this country are sufficiently acquainted with these materials to warrant them in preparing such specifications. Many who have attempted the task have failed because of lack of accurate information which has led them to combine and make use of portions of specifications prepared by others. Such combinations have most often proved utter failures, some of which are ludicrous, inasmuch as they have actually defeated the object for

which they were presumably drawn. Others have been impossible because of the fact that certain clauses or test limitations prescribed were incompatible.

In this connection it may be said that while the average highway engineer will not find it practicable or even necessary to also become a highway chemist, he should nevertheless possess as a part of his practical working equipment some knowledge of the chemical and physical properties of bituminous materials and methods of testing them. A lamentable lack of such information is apparent in many highway engineers who, in other branches of their profession, are thoroughly capable and efficient. Opportunities for obtaining instruction along this line are now being offered by at least one of our universities, and many engineers should find that the comparatively short time required for this purpose could not be spent to better advantage.

One other point may be mentioned regarding the preparation of specifications which is directly connected with test limitations, and this is the matter of allowable variations in results which may be looked for from different chemists and different laboratories. In the first place it should be remembered that at the present time there are comparatively few standard methods for making tests which have been generally adopted. Variations in results are frequently attributable to variations in methods of testing. It is, therefore, good practice to include, in or as a part of specifications, descriptions of the methods to be employed in testing. This is especially true where specifications are to be widely used.

Besides the above mentioned cause, a certain variation in results may be expected from what is termed the personal equation. Thus, no matter how clearly defined a method may be nor how conscientiously followed, it is the exception rather than the rule when two operators working on samples of the same material obtain exactly the same results. In fact, a single expert operator will seldom check himself exactly, although his results may be identical in so far as their practical application is concerned. Moreover, it should be realized that in substances as complex in character as are bituminous materials, however carefully prepared or manufactured, there is apt to be some variation in samples of the same batch whether taken from the same still, tank, kettle, barrel or even from the same sample can.

Just what the allowable variation in results should be when all of these conditions are taken into consideration, is a lengthy matter to discuss. It is certainly not the same for all tests, nor even for the same test applied to different

classes or grades of material. Thus in the ordinary volatilization test a variation of one per cent. in results obtained upon a material losing 15 or 20 per cent. would be perfectly reasonable, while in a material losing 2 per cent. it would be an inexcusable variation. Owing to lack of time, the author does not consider it advisable to attempt a detailed discussion of this subject in the present paper, but suggests it as a topic for consideration.

He would further suggest that certain tests of more or less questionable value for use in connection with specifications, be considered at this meeting, among them being the determination of paraffin scale and the determination of the so-called asphalt contents of petroleum products. The misapplication of such tests as ductility and fixed carbon should also prove a fruitful source of discussion.

In conclusion, the author wishes to state that while this paper may appear to deal with specifications in general more than with the actual testing of materials, it should be remembered that specifications are, in effect, definitions, and that from a broad standpoint definitions are themselves fundamental tests.

PRESIDENT HILL: Gentlemen, a very interesting paper has been presented by Mr. F. P. Smith, Consulting Chemist and Paving Engineer, of New York City, who is unable to be present.

FRANCIS P. SMITH (Dow & Smith, Consulting Paving Engineers, New York, N. Y.)*: While the speaker agrees with much that Mr. Hubbard has said, he does not consider that his objections to the so-called blanket type specifications are valid, more especially with respect to asphalts. The asphalt paving industry is by no means a new one. For upwards of forty years pavements and roadways of this type have been in use in this country. The speaker has for eighteen years been closely identified with this industry and during that period has had charge of the mining and refining of asphalts and the laying of bituminous pavements of all kinds and he, therefore, believes that he is qualified to judge and justified in stating that the requirements of an asphalt for paving purposes are well understood and are comparatively simple and have nothing to do with the source of the material. For specification purposes he considers that so-called identification tests are unnecessary.

The function of an asphalt cement or asphalt binder is to

*Written discussion sent in but not read at the convention.

cement together the particles of the mineral aggregate which forms the roadway. In order to do this it must be possessed of sufficient cementitiousness or binding value. If it fails in this, it is useless as a cementing material. It must be sufficiently pure; i. e., contain sufficient bituminous binding material, to make it available for use. It must be of such a consistency that it can be properly applied to the mineral aggregate in such a way as to thoroughly coat each particle of it. It must not be too susceptible to changes in temperature; i. e., become too hard in winter or too soft in summer. It must not harden too rapidly when heated in the melting kettles, and when exposed to the elements it must maintain its original properties for a sufficient length of time to give satisfactory service in the pavement or roadway.

All of these properties are determinable by well known tests and these tests must be met by all asphalts before they can be considered suitable for paving or road making use. It is true that different asphalts vary in their properties. Some are purer than others; some are more susceptible to changes in temperature or to prolonged heating; and some have higher cementing values than others. Experience has shown that a suitable asphalt for paving purposes need not possess all of these qualities in the highest degree, but sufficiently so for practical purposes. From past experience, however, it is perfectly possible to clearly define minimum limits which all asphalts must pass in order to be accepted with safety for paving work. Having done this, you have established the ideal specification of the blanket type which calls for all the necessary qualities and does not differentiate as to source but as to quality only and is not of excessive length.

This fulfills the first purpose of a specification for bituminous road and paving materials as defined by Mr. Hubbard. Except in special cases, just why a specification should state at great length a number of tests for identifying the material, as stated by Mr. Hubbard to be the second purpose, the speaker fails to see. Anyone really competent to test bituminous materials for paving or road making purposes can identify them just as easily without a specification as with one, and certainly the contractor does not require this information to enable him to bid intelligently.

As to securing uniformity in the preparation or manufacture of a material, it would seem to be a simple task to insert a clause in a blanket type specification stating the maximum permissible variation in different shipments of the same

class of material. To further insure that one manufacturer shall not adulterate or lower the quality of his material in any respect or respects so that it will *just* meet the minimum requirements of the specification, it may be required that all shipments of material shall be fully equal to the established standard and recognized quality of that particular brand.

Mr. Hubbard uses the variations in desirable consistency of different asphalts as an argument against blanket type specifications. Assuming that the wide variations which he cites are altogether normal, these are by no means wholly dependent upon the source of the asphalt. The considerations which affect desirable consistency or penetration are:

1—Purity.
2—Susceptibility to changes in temperature.
3—Character of mineral aggregate.
4—Climatic and traffic conditions.

As to purity, the fluxed Bermudez which he cites contains about 96 per cent. of bitumen, and the California about 100 per cent. of bitumen. There is too little difference in this respect to afford an excuse for separate specifications.

As to susceptibility to changes in temperature, the California is much more affected by temperatures up to 140° F.; i. e., softens more readily but, on the other hand, loses less when heated to 325° F.

The character and grading of the mineral aggregate, however, have as great an influence on the desirable penetration as the susceptibility of the asphalt to temperature changes.

The climatic and traffic conditions for any one particular piece of work will be the same in each case and may, therefore, be dismissed from consideration.

Until the material is actually assembled, however, it is impossible to state with certainty just what will be the proper penetration or consistency of the asphalt cement or binder, as it is impossible in most cases to draw a specification which will call for a mineral aggregate possessing a predetermined and definite degree of stability, and upon this the desirable consistency of an asphalt cement or binder largely depends. This consistency is something which the trained and experienced engineer can and should determine while the work is in progress. While this argument applies more forcibly perhaps to sheet asphalt pavements than to asphalt macadam, it is nevertheless true of both types of construction and may be readily met by a clause in the blanket type specifications to the effect that the exact degree of penetration or consistency within the limits established by the

specifications shall be determined by the engineer in charge, depending upon the kind of material used and the traffic upon the roadway to be paved.

On the other hand, let us assume that a separate specification is to be prepared for each kind of asphalt. Those commonly in use are prepared by refining or fluxing, or both, Gilsonite or crude asphaltic material obtained from California, Cuba, Mexico, Texas, Trinidad and Venezuela. All of these differ essentially in purity and susceptibility to changes in temperature and from the standpoint of consistency or penetration should, therefore, according to Mr. Hubbard, be considered separately. This would make seven separate specifications. In the case of Gilsonite, the character of an asphalt cement or binder made from it would depend entirely on the kind of flux used with it, so that Gilsonite products alone might require two or more specifications. The same is true, from the road binder standpoint, of Trinidad, Cuban and Bermudez, while with California and Mexican asphalts the method of distillation used greatly affects the character of the product. In fact, the New York City paving specifications call for a special type of California asphalt much less ductile and susceptible to temperature changes than the standard California paving asphalt which has been successfully used for many years throughout the United States and is exclusively used on the Pacific Coast. Again, what is to hinder any manufacturer from combining two or more of these asphalts, as has been successfully done in many cases? To carry the separate specification idea, therefore, to a logical conclusion would involve the writing of an encyclopedia which would need constant revision; and to separate the materials into two or three classes would be a poor compromise, leading to invidious distinctions in many cases, perhaps even to unfair discrimination, as it has done in the past. Such a compromise would, in the speaker's judgment and experience, be far worse than anything which has been alleged against the blanket type of specification.

In the early days of the paving industry, closed specifications and high prices were the rule. As knowledge and experience in the paving industry have been acquired by engineers, closed specifications have become more and more rare, and under proper blanket type specifications price has declined and quality has been maintained. The type brand of specification was tried and abandoned as too cumbersome and the speaker freely admits that some years ago he advocated and drew a number of such specifications but later became convinced that they were unnecessary and cumbersome and so abandoned them.

With regard to the fixed carbon test, the speaker considers that this is solely an identification test and therefore has no place in a specification unless it is desired to call for a particular kind or type of asphalt. This, as Mr. Hubbard states, may be perfectly proper in certain instances, but not where open competition is desired.

Many excellent pavements have been laid with California asphalt containing 16 per cent. and even 17 per cent. of fixed carbon and it may, therefore, be considered at least doubtful whether the presence of this amount of fixed carbon in California asphalt is a sign that it has been injured in the process of manufacture.

The specific gravity test is undoubtedly of value as an identification test, but it is perfectly possible to recognize a blown asphalt without having recourse to this test, as, for instance, by the use of the ductility test. It is also questionable whether a certain amount of blowing is not the reverse of injurious so long as the ductility or cementing value is not reduced too greatly. Air blowing during distillation reduces susceptibility to changes in temperature and within limits and for certain purposes this is highly desirable.

A word with regard to the paraffine test: The speaker believes that it has been conclusively proven that the presence of paraffine scale, per se, does not necessarily injure an asphalt for paving purposes up to say 10 per cent. and possibly beyond that. The advocates of this test have recently taken the position that it is valuable as indicating the presence of an undesirable amount of paraffine hydrocarbons in an asphalt, oils consisting largely of paraffine hydro-carbons being recognized as unsuitable for the production of asphalt. To dispose of this claim it would seem to be only necessary to cite the case of many old and excellent pavements laid with Trinidad and other asphalts which contained over 25 per cent. of flux composed almost wholly of paraffine hydrocarbons. If 25 per cent. of paraffine hydrocarbons is not injurious, where is the line to be drawn? It seems only reasonable to relegate this test to the class in which it really belongs, viz., the identification class, and rely on tests measuring the essential qualities of an asphalt when it comes to determining its fitness as a paving or road making material.

With regard to the ductility test: This has frequently been criticised by those who apparently do not understand its true scope or function. It has been claimed that the most ductile materials at ordinary temperatures, say 77° F., are those which are least ductile at low temperatures. This

is not true. Great care must be taken in making ductility tests at low temperatures, otherwise the briquette will crack and no ductility will be reported. What is true is that the most highly ductile materials lose relatively a greater proportion of their ductility at low temperatures than do low ductile materials, but it must be remembered that even at 77° F. the latter class has practically no ductility to speak of. In the speaker's experience and in that of many others, the ductility test more nearly measures the cementing value of an asphalt than any other test known, and it is in that that its chief value lies. In this connection I will quote some remarks recently made by Mr. C. N. Forrest, of the Barber Asphalt Paving Co., concerning the ductility test:

There is another fallacy in connection with the ductility test. It has been asked why should not the material be ductile at 32° F., the supposition being that when a pavement expands and contracts, the resistance of the asphalt, under those circumstances, is dependent more or less on ductility, but the ductility test as performed according to the general way of doing it, as we know it, is a measure of the cementitious value. To produce a material that is ductile at 32° F. is to produce a short material; that is, if it is ductile at 32, it is not ductile at 77, and that would be done by the same method as increasing the toughness—by using a blown oil.

The ductility test has nothing whatever to do with the capacity of the asphalt to give and take with the expansion and contraction. As a matter of fact, the asphalts which are rubbery and show some resistance to impact and show some ductility at a low temperature will seldom show enough for sheet asphalt. They will crack in cold weather, although they are rubbery and show resistance to temperature changes.

As to variations in results as mentioned by Mr. Hubbard, the writer has often seen determinations reported in hundredths of a per cent. when the method employed was not accurate within tenths of a per cent. In similar cases, he has also known material to be rejected because it exceeded the specification limits by two-tenths of a per cent. where the method used was not accurate within one-half of one per cent.

In conclusion, the speaker wishes to most heartily concur in Mr. Hubbard's statement as to the necessity for an understanding of the individual significance of the various tests and the relations of the different tests to each other. Without this knowledge the preparation of proper specifications and the interpretation of them is impossible.

PRESIDENT HILL: The discussion will be continued by Mr. J. E. Myers, Chief Chemist of the New York State Highway Commission:

J. E. MYERS (Chief Chemist, New York State Highway

Commission): Without going deeply into technical detail, the author of the paper "The Testing of Materials for Road and Street Construction," has treated the subject in a very comprehensive manner.

Since the subject of testing materials, as considered in the paper referred to, is so closely related to specifications governing road and street construction, it is impossible to consider the subject of testing materials without also considering the specifications governing the materials and their use.

By a careful study of the stone roads constructed with the use of bituminous materials, it would seem that these roads might be classified, with reference to the bituminous material, as coming under one of three general types. According to the method of construction used these types of roads are generally known: First, as the water bound, bituminous surface treatment; second, as the penetration or grouting method, and third, as the mixing method.

Since the liquid bitumens used in the first type of construction are largely used for dust prevention, they are not considered a part of the permanent construction, and will not be given further thought in this discussion.

Experience has shown that the bitumens which give satisfactory results as binders, in either the penetration or mixing method of construction, possess certain well defined, general characteristics.

These characteristics are; First, the bitumens must be adhesive and sticky; second, the bitumens must be pliable at all temperatures to which the road surface will be subjected, without becoming extremely soft in warm weather and without becoming extremely brittle in cold weather, and third, the bitumens must be stable under atmospheric conditions, that is, the bitumens should possess the first two characteristics, and retain them under service conditions.

Experience has also shown that the bitumen should be somewhat softer for the penetration or grouting method of construction, than for the mixing method. The other characteristics of the bitumens for penetration work and mixing work are the same. This would call for specifications, differing but little if at all, in anything except the hardness of the material, or, as it is usually termed, the penetration.

The author of the paper under discussion stated in his paper: "Products of innumerably varied and complex characteristics may be produced from a given crude material by modifying the methods of manufacture." This statement is unquestionably true, and it would seem that for each type of construction an open blanket specification, requiring the

characteristics of the material desired, and amply guarded by supplementary tests or requirements, is preferable to a number of separate specifications covering materials from different sources, as suggested in the paper referred to.

A blanket specification, to a large extent, does not consider the source of material, but requires the process of manufacture to be such as to produce a material with the desired characteristics. Certainly, the "fallacy of blanket specifications" is not "easily demonstrated" and is, to say the least, a subject open to discussion.

It has been suggested that certain tests, as specific gravity, fixed carbon, paraffine scale, and possibly others, are unnecessary and absurd. Possibly such a statement would be true were each requirement considered by itself, but if properly drawn the interrelation of these requirements will demand a uniform material of the desired characteristics.

Uniformity of material under blanket specifications, is only secured by a number of interrelated tests such as specific gravity, solubility in carbon disulphide, solubility in certain grades of paraffine naphtha, fixed carbon, paraffine scale, ductility, toughness, flash point, evaporation loss, character after evaporation, etc. The importance of the interrelation of these tests has been fully discussed in the paper referred to and will not be further considered.

PRESIDENT HILL: The next paper will be by Mr. C. S. Reeve, Chemist of the U. S. Office of Public Roads.

C. S. REEVE (Chemist, Office of Public Roads, U. S. Department of Agriculture): The speaker takes occasion to first congratulate the author of the original paper for his excellent review of the purposes to be accomplished by tests and specifications, and there are but few points upon which one can take issue.

Those of us who frequently have occasion to review specifications are familiar with some of the many fallacies of the blanket specification, which is frequently drawn with but little knowledge of the values involved. And yet, for some reason, there is a conviction with many that separate specifications destroy competition, and this is frequently an argument against such a form. It must, however, be assumed that all conforming materials will prove acceptable, since otherwise there should be no request for bids upon them, and, looking at it from this standpoint, there can be evidently no change in the competitive character of the materials. To the speaker's understanding, Mr. Hubbard simply advocates that each type of material advertised for shall prove acceptable, but that each must meet the requirements

of its particular class. In this we heartily agree, but the speaker would advocate the least possible number of specifications that will satisfactorily attain the desired result.

On the other hand, we do not question the legitimacy of the single discriminating specification, when it is issued with a full knowledge of its intent, and with honest purpose that can be supported by convincing reasons. The highway engineer does, however, display a lack of knowledge upon the materials with which he is dealing when he accepts without question such a specification with the understanding that it is a competitive one.

Another case in which the need for reliable technical information is evidenced appears when an engineer will accept and issue a specification embodying tests which cannot be carried out. For instance, to specify that a complex emulsion shall contain a fixed amount of an oil possessing certain definite characteristics, is useless unless the engineer is prepared to make a plant inspection of the separate components and the process of manufacture.

While admitting the utility of separate specifications for bituminous materials, the speaker, if his understanding is correct, is inclined to disagree with the author upon one of the reasons advanced. The reference is to the following statement:

> Thus, for a certain type of bituminous concrete pavement the proper penetration limits at 25° C. for a California asphalt may lie between 7.0 and 9.0 millimeters, while the proper penetration limits for a fluxed Bermudez asphalt to be used in exactly the same type of pavement and under the same conditions, may be entirely different, say from 14.0 to 16.0 millimeters.

Now, we have no form of bituminous concrete in mind in which such a wide divergency, if any, in the penetration of the material would be made, dependent upon whether California or fluxed Bermudez asphalt were used. Some other expressions of opinion upon this point would no doubt prove of interest.

Among the several subjects suggested by the author for discussion is allowable variation in results of tests. To the speaker's mind, this is really not a matter that can be decided by any hard and fast rules or lengthy discussion. That some tests are not sufficiently well standardized and that the personal equation gives rise to variations in results goes without question. Lack of consideration of this aspect of testing frequently leads to a rigidity of interpretation that works undue hardship to both manufacturer and contractor. However, this would seem to be a matter that can only be left to the judgment of the engineer or chemist. He should,

of course, be sufficiently informed to realize the possible variation in results, and, taking this in conjunction with the circumstances underlying the case in question, must decide in accordance with his best judgment.

The author has referred to several specific tests which should prove fruitful sources for discussion. To just what extent it is the purpose of this meeting to enter into the technique of tests, the speaker does not feel sure, but for purposes of discussion, a few remarks on a test of considerable recent prominence may not be out of place. The reference is to the paraffin scale determination. While no standard method for making this test has thus far been recommended, it is the usual practice to distill the bituminous material to coke and to precipitate the scale from an aliquot portion of the distillate by means of an ether-alcohol mixture at a temperature of —18° or —20° C. The speaker has always considered this test a rather inaccurate determination, and his stand in this regard has been fully justified by the work of several investigators. It has been quite clearly demonstrated that different experts using exactly the same method obtain results that differ so widely as to permit of no definite interpretations whatever. We therefore feel that, regardless of the effect of the presence of paraffin scale or the hydrocarbons it represents, a more accurate method of determination must be established before we can justifiably place closely defined limits on the amount of scale allowable.

PHILIP P. SHARPLES (Chemist, Barrett Mfg. Co.): Mr. Hubbard's paper presents, in a very admirable form, the subject of specification and testing. There are one or two points, however, that I think might be further brought out, that it would be interesting to put on record. In making up specifications at the present time, I think it is very important, before putting them out, to consult a number of the manufacturing chemists. Where this plan is carried out intelligently, I think it leads to very good results and prevents the putting out of specifications that are impossible of fulfillment by the manufacturer. The time has now come when the chemists of the different state highway organizations or of the large users of materials can get through the sales force to the chemists of the manufacturer. I think it is very important to cement this friendship that has begun and for the consumer's chemist or engineer to get the benefit of the point of view of the manufacturer's chemist before putting out specifications.

There is another important point that perhaps Mr. Hubbard did not dwell upon at great enough length. It is a very

important matter in itself and its neglect leads to a great deal of trouble in the testing of materials. I speak of the importance of taking samples at the proper time. Many a time samples of bituminous materials which are used for testing are not taken at the time of the receipt of the material but some time during the manipulation of that material on the road. The material tested, therefore, does not represent the material shipped. It is very important in every case, it seems to me, to take extraordinary care in taking samples, and that point, I think, cannot be too much emphasized.

Another point that Mr. Hubbard has perhaps not brought out, and is along this same line, is that tests should be made during the use of bituminous materials on the road, as great changes can be brought about by the mal-treatment of the materials by the users. This is particularly so on materials which have easily volatile constituents that will be driven off through overheating or through long continued heating at a low temperature. This is a subject that has not been given sufficient attention in the testing of road materials. I thank you for your attention. (Applause.)

PRESIDENT HILL: Is there anyone else who cares to offer any remarks on this subject?

H. B. PULLAR (H. B. Pullar Co., Detroit, Mich.): I want to say just a few words in discussion of Mr. Hubbard's paper. The speaker heartily agrees with almost everything he says, but thinks there are a few other points that might possibly be brought out.

There are two things specifications are for. An engineer comes to you and asks for specifications; he says, "First, I want a specification that will insure me of a good material; second, I want a specification that will insure me of getting a uniform material after I begin to receive it."

There are two contradictory statements there. If you want a blanket specification open to the broadest competition, there's only one thing to do, and that is to have this blanket specification cover practically every kind of material. If you do that, then you get the competition, but you lose the one point that some engineers seem to think of—getting in competition only those materials that are good. That is a pretty hard thing to do. You cannot bar out poor materials and admit only good ones in a blanket specification.

I think there is one idea that might be taken into consideration in that, if you have a blanket specification, you may have one or more clauses in another part of the specification that will enable you, in calling for bids, to obtain samples

under this blanket specification. Then, after the specimens have been received and tested, draw up auxiliary specifications and in these draw your limits close enough to be sure of getting uniform material during the progress of your work. If the engineer wants, in the first place, to draw this specification so as to get only the good materials or those which he, in his own mind, considers to be good, then he ought to divide the materials into different types and call for bids under this specification, eliminating by this method undesirable materials, as Mr. Hubbard stated.

Then I think there is a point that has not been brought out at all in the discussion; I think that local conditions have a great deal to do with specifications. For instance, on the Pacific Coast they are using the same kind of specifications that they are using in this part of the country, and I do not think there has been any other than California asphalt used, or at least such a small percentage of other materials has been used that it should not be taken into consideration. Why wouldn't it be best to draw a strict specification for California asphalt? I know of one instance where the specification was so broad that a small refinery in California supplied asphalt which was absolutely useless. It was burned, improperly prepared, and utterly worthless as a binding material. A good specification for California asphalt would have kept out this material.

Now, Mr. Hubbard has requested discussion on a number of tests which he thinks might be eliminated or which have been suggested. There have been several materials on the market lately that have different characteristics. For instance, the Mexican asphalts, as Mr. Hubbard says, have a high fixed carbon. Now, the other properties of Mexican asphalt seem to classify it as a very good bituminous material, and for this reason I think that a higher fixed carbon for Mexican asphalt could be reasonably allowed, but I certainly would not advocate the elimination of the fixed carbon test. It all comes back to dividing the different bituminous materials into different classes and calling for bids under those different classes, or, in my opinion, drawing a blanket specification admitting the widest competition, and then drawing strict specifications covering the material accepted, so that you will get uniformity.

I think a point Mr. Sharples brought out would be a good thing to take into consideration, that is, consult the manufacturers to see what limits they suggest. For instance, a limit of ten points in penetration is sufficient for some materials, whereas it would be almost impossible for

another producer to get out materials within those limits. In this case there ought to be a limit of, say, twenty; and the same thing is true in fixed carbon and other tests. Some can keep within a limit of one or two points. As Mr. Hubbard says, it would not be just to condemn one material because it was volatile and had a variation in volatilization of 1 per cent. where the total volatilization was 20 per cent., whereas it would be just to condemn a material having a variation in volatilization of 1 per cent. when the actual volatilization was 2 per cent. I think those points ought to be taken into consideration. (Applause.)

PRESIDENT HILL: Gentlemen, before we take up the next subject, I am going to ask your kind consent to hear the report of the committee on resolutions. I understand that the report is ready, and the committee requests that we receive it at this time.

[Mr. Rogers then read the following report.]

Resolutions

WHEREAS, It is the expressed purpose of the American Road Builders' Association to acquire and disseminate information and to stimulate interest and to promote legislation and other measures in the interest of the building and maintaining of highways; and

WHEREAS, It is increasingly evident that this work can best be accomplished by complete cooperation or amalgamation with other associations working for the same broad purposes; and

WHEREAS, The Federal Congress will in the near future take some action leading to the participation in the building of roads by the government; and in order that such legislation as is enacted should be fair, just and equitable and that the monies that are appropriated should be spent without undue influence of politicians; it is advisable that the road organizations should present a united point of view to Congress.

NOW, THEREFORE, BE IT RESOLVED: That it is the sense of this association that an earnest effort should be made for a complete understanding with such other national road associations as have similar ideas, and, for this purpose, the President of the American Road Builders' Association be and hereby is authorized to appoint a committee of three, of which the President shall be a member and chairman, with full powers to act and to meet with similar committees from other road associations and consider, and, if possible, perfect a complete amalgamation.

RESOLVED, FURTHER, That we herewith petition the Congress of the United States to authorize the President to appoint a commission from civil life and make a sufficient appropriation to said commission to enable it to make a thorough investigation of the whole question of federal appropriations for road construction and that this commission shall report its findings to the President.

WHEREAS, There have been held during the past year several national road conventions on elaborate scales, necessitating great expense on the part of delegates and exhibitors; therefore be it

RESOLVED, That it is the opinion of this convention that all national road organizations holding or intending to hold such conventions should unite and next year and succeeding years hold but one annual road congress, and we would suggest that said congress be held during the month of March.

WHEREAS, The rooms assigned for holding the sessions of the road congresses in recent years were wholly unsuited for the purpose, resulting in great annoyance to the delegates, thus reducing the value of the congresses; therefore be it

RESOLVED, That there should be provided in the future halls suitable for holding the sessions of the congresses, far enough removed from the exhibits to be free from confusion and noise.

RESOLVED, That the sincere thanks of this Convention be extended to the Governor of the State, the Mayor and Citizens' Committee of this city for their cordial welcome, and the many courtesies they have extended to us; and to the press of the city for the splendid and extensive manner in which they have reported this Convention.

FRANK F. ROGERS,
Chairman.
JOSEPH HYDE PRATT,
Secretary.

[It was moved, seconded, and voted that the report, as read, be adopted.]

PRESIDENT HILL: The next paper was to have been presented by State Highway Commissioner J. N. Carlisle, of New York, but he is unavoidably detained. However, we have with us today, Col. Wm. De H. Washington, who, with our Vice President, Harold Parker, and Mr. George C. Diehl, compose the Advisory Board of Consulting Engineers of New York. I am going to ask Col. Washington to read the paper.

SUB-ORGANIZATION FOR SECURING EFFICIENT MAINTENANCE

By J. N. CARLISLE,
State Highway Commissioner of New York

The really great problem confronting those who are in charge of state departments of highways is maintenance. This question involves not only a study of the methods to be adopted for properly keeping the roads in repair, but first involves the question of what scheme of organizing a department can be installed to procure such a result.

In New York state up to this year the construction of highways was under the charge of division engineers, and the maintenance work was separate and apart and was in charge of a maintenance bureau under different divisions and superintendents of maintenance. This plan of divided authority was so unsatisfactory that in the winter of 1913 the Legislature of New York provided that the work of construction and maintenance should be consolidated under the control of the division engineers, and that the work of maintenance should be done either by contract or directly by the department.

Our state is divided into nine divisions, with a division engineer in charge of each, and we intend to subdivide each of these divisions into about seven subdivisions, making sixty-three subdivisions of the state. In charge of each of these subdivisions we intend to appoint an assistant engineer, and put him in charge of both construction and maintenance in his territory, requiring him to have an office and live therein, and to hold him rigidly responsible for the condition of his roads.

The New York plan in the past has been to rely largely upon patrolmen, that is, the placing of a man with a horse and wagon in charge of a small number of miles, and imposing upon him the duty of keeping his section of the road in repair. With a state so large as New York, this plan has not worked out to our satisfaction, and while we do not believe in entirely abandoning the patrol system yet we are arranging for an organization of section gangs in each of the subdivisions, each section gang to be furnished with equipment with which roads can be oiled and repaired.

No railroad company today would think of trying to keep its tracks in repair simply by a patrol system, and we believe that in following the methods of the steam railroads in taking care of their tracks we can accomplish better results than in any other way. This problem, of course, means the organization of a proper section gang with equipment sufficient to

do repair work. Our plans call for the furnishing of an automobile truck, pressure sprayer oiler, a steam roller, and heating tanks, together with small tools, so each section gang will be large enough and well enough equipped to properly repair any kind of road already constructed.

With section gangs properly organized, and with sufficient equipment under the direction of an engineer who is held responsible, we ought to produce a sub-organization which can give efficient maintenance. This section gang should be organized strong enough to clean and oil the roads at the proper season, make temporary repairs, and when this preliminary work is done, do heavy permanent repairs on our roads.

COL. WASHINGTON: I will say, gentlemen, that the report of the advisory commission or board of engineers appointed by the state of New York advises the track gang, or the application to roads of the track gang principle, such as is employed on the railroads.

One of the members of that advisory commission has endeavored to make a combination machine that will carry all of the materials necessary to repair a road of any type and carry them in the best possible form—that is, if you have a bituminous road, it will carry hot tar and carry the stone of different sizes also hot, having had the moisture expelled.

If we have a machine that also carries with it its own road roller, and carries water if a water bound macadam is to be repaired, and in fact carries every material and is a combination of all the road machines, it not only enables you to apply the track gang principle but it enables you to apply power to almost every one of the operations necessary for the repair of a road. Such a machine can get over the road quickly and can carry the whole gang over a road at a speed of say 15 miles an hour. So you can see that your gang is very mobile.

We estimate that we ought to be able, with a gang of not to exceed 4 to 6 men, to take care of a hundred miles of varying types of highways.

If you gentlemen wish to see the machine that the state of New York proposes to try out at least, you will find a drawing of it at the other end of the room and I will be very glad to explain it to you. (Applause.)

PRESIDENT HILL: Now, gentlemen, discussion is next in order and we will have the pleasure of hearing from Mr. C. J. Bennett, State Highway Commissioner of Connecticut.

CHARLES J. BENNETT (State Highway Commissioner of Connecticut): In discussing the broad subject of sub-organization for securing efficient maintenance on a highway system, I cannot say that I entirely agree with the gentleman from New York in his idea of standardizing a system of maintenance. With any system of highways in the United States at the present time, the class of roads, the location of the road, its length and its proximity to centers are so varied that you cannot standardize any system, as I see it, all over a state; so that, in my opinion, there should be some variation of a system of sub-organization which will apply itself to these different types of roads, locations, etc., in a manner which will give the very best result. In order to emphasize that idea, I want to suggest three different types of organization which can be placed under one general executive head, and used to good advantage.

First, the section gang system, for any closely related system of highways, that is, any system of highways which radiates from one center, running out in different directions, where you can install a gang and let that gang go out in different directions every day and get the ultimate and most service out of it.

Second, the patrol system for long stretches of permanent highways which run for many miles through the country and are built with a modern surface and need slight repairs from time to time. To such a highway the patrol system is very well adapted and can be used to good advantage.

The third system of maintenance is the care of the road which is way back in the country, the road built in some small town to accommodate that town and make it possible for the townspeople to get to their center, out of the town or into another town. On that road we must have somebody in the town or near the town who can look after the road at needed intervals. Such a system I call the periodic system of maintenance.

I think with a combination of these three systems we shall get better results than with the standardization of any one particular system.

In connection with the permanent repairs of the road I have found that possibly it is wiser to contract the extensive repairs rather than provide a sub-organization for their making, feeling that the contractor who is properly equipped with an organization—the man who is making a living out of that particular class of work—can give us better service on extensive repairs than our own men. I also do not agree

with the previous speaker in the placing of repairs and construction in the same department. Possibly we are ruled more by conditions in our own state, although it seems to me there are one or two broad principles connected with this kind of work which make it necessary to divide the construction and the maintenance. The first is that maintenance is by far the more important of the two divisions, in my estimation. We also need trained supervision, we need constant supervision, and we cannot get men who will spend too much time on the maintenance of the roads themselves. These men must be trained along a particular line to do things in a certain way, and their minds should not be clouded with the construction problems of new highways, only so far as the repairs on that road, after it is built, influence them. Furthermore, I find that with the construction engineers, their interest is a great deal more in construction than in repairs, on the same principle that you like a new suit of clothes better than an old one; you like to build things and see them grow under your hand, but when they begin to lose their identity as new articles you begin to lose your interest in them. Now, if you make it impossible for a man to have any interest in construction other than the casual interest in seeing that the work is completed along proper lines, make him stick right to that one line, maintenance, keeping his roads up in shape, make that his sole interest in life, I think you will get better results.

Now then a word as to the organization of the force itself—and this is the keynote and the heart of the whole matter. I spoke a few minutes ago about the difficulty of doing work, state work, with your own forces. It has been, as you gentlemen are all aware, exceedingly difficult for state officials or city officials to secure men, rank and file laborers, who will work as arduously and as hard for the state as they will for a contractor. I don't know the exact reason for that, but it is a fact. At the same time I am sanguine about the situation. I believe that a system of labor gangs can be built up in a slow way by a highway department so that we will get efficient service and constant and hard work, and I would go about it in this way: In the first place, the man at the head must see that he surrounds himself with sub-heads who are efficient, honest and capable, and that is a pretty big order to start with. Those men should be instructed that the men they pick for their foremen, for their heads of small gangs, should be the same type of men, with possibly a little less mental equipment, but men who will be available at all times, and whom you know

will be on the job. There should be a fixed rule, gentlemen, against the use of intoxicating liquôrs by these men, and they should be selected for certain moral characteristics as well as for physical ones. Now, having built up a small organization of this kind the highway commissioner or the superintendent of repairs or the superintendent of a district, should make it his duty to get acquainted with the men under him. He should know those men, not only as workmen, but as associates. This silk stocking attitude toward the men under you is not going to pay, but you want to get right next to that fellow and live with him, take him right into your own life and make a friend of him; make his aim yours and yours his; make it possible for him to know that your sole wish is to get good results in the maintenance of roads and that you want him right with you; appeal to his sensibilities and to his sense of honor. And that is the way, gentlemen, to handle a sub-organization of maintenance, in my opinion. Furthermore, you should get so that you know, if possible, most of the foremen by name, and at least hail them when you go in your machine and say, "How d'ye do, fellows, how are you getting along?" Even if you can't spend but half a minute with them, let them know that you are on the job as well as they are, and don't let them work any harder than you do. (Applause).

PRESIDENT HILL: Gentlemen, Mr. Ross.

C. W. ROSS (Street Commissioner, Newton, Mass.): I have got a very bad throat, Mr. President, but I had it before I came here. I did not expect to say one word, but this question of maintenance of streets is something that I am very much interested in.

I have had charge of the streets in our city for 24 years, and we have about 144 miles of public streets in the city of Newton, Mass. I think that we were one of the first cities to organize gangs of section men to care for the cleaning and making of minor repairs on the streets, and I believe that the paper read by Mr. Carlisle well expressed the needs of the state of New York or any other state.

In Newton, Mass., we put on all the tar and oil preparations and do all the patching and repairs by day labor, not by contract. We do not let out any of our street construction or maintenance work. I find that when it is necessary to put on any kind of a bituminous or oil treatment, you want men that understand that class of work; and it is advisable to keep them right at it.

Now, as has been suggested at this convention, if you have a foreman who understands the business and he is provided

with a sufficient number of good men, better results will be obtained by giving him an equipment suited to the kind and amount of work he has to do.

It is advisable to employ men that have grown up in the business of road construction. We don't hire a man and keep him six months, but we keep him the year through, if possible, and all of our sub-foremen are men who have been with us a considerable period, some as long as 30 years, and we endeavor to employ them continuously, training them in certain lines. If one man is good at paving, he is retained in that department; if another man is good at setting curbstone, he is employed on that work; and similarly in putting on oils, tar and other kinds of bituminous preparations.

There has been a great deal said here by the chemists. I am not a chemist, but I have had some experience as a practical road builder. If you take a carload of any bituminous material, put it on a sidetrack, let it stand for a week, and then draw off from the bottom of the car, you will get an uneven mixture. A chemist may give you an analysis of that car and it may be all right, but when you unload it the lower half may be better than specified on account of the settlement of the heavier material; then when you draw the remainder, it is likely to be a very light material and you blame the firm of whom you bought it for sending you poor material. In many cases, in unloading, the material is found to have been overheated.

Now you will get better results by having a practical man in control of every section, who knows his business, who knows how hot material ought to be put on, who knows just what kind of material to put on and who knows just how many miles of street a gang of a certain size can take care of. This coming year we have got an extra appropriation for that very purpose, putting on gangs of men on maintenance work all over our city. We have about 144 miles of streets and we calculate to take care of every one of them by the section gangs. If it can be done in a city, it can be done in a state. I was fortunate enough to serve three years on the State Highway Commission of Massachusetts, and we installed a patrol system, and am of the opinion it is the proper way. If every city and state will get right down to business and have an equipment that they can do the work with, there will be less criticism and less poor roads and more thanks to everybody than at the present time. (Applause.)

PRESIDENT HILL: Gentlemen, you will have the pleasure of hearing from Mr. Ross this afternoon also, but at

the present time I will call on Mr. J. S. Gillespie, Road Commissioner of Allegheny County, Pa., who yielded to Mr. Ross that he might make a statement at this time. Mr. Gillespie. (Applause.)

J. S. GILLESPIE (Road Commissioner, Allegheny County, Pa.): Gentlemen, I thank you for the applause. I always like to get the applause before I start (laughter), because I am suspicious when I get it when I finish.

An old Scotchman was to give a talk. When he came home that night his good wife was waiting for him, and she said: "John, how did you get along?" He said, "Fine, Maggie, fine." She said, "Did you get any applause?" "Aye," he said, "I didn't get much applause when I got up, but, O, Maggie, the lot of applause I got when I sat down." (Laughter). So I like to get it before I start. (Laughter.)

Mr. Chairman, and Ladies and Gentlemen: In taking up the discussion of the paper of Mr. Carlisle I agree with him and I disagree with him. I agree with Mr. Bennett; in fact, if I had made notes and lost them I would have said he picked them up. I disagree with him a little, and I have no doubt before I get through that there will be some men in this convention who will disagree with me. I am going to agree in the matter of sub-organization. I am going to disagree with Mr. Carlisle in the manner that he is going to run it, and what I say to you on this subject is the result of my own experience. I find in this road business that there is a little bit too much theory and not enough practical work, and I am going to give you the practical end of it.

I have the pleasure of having charge of the maintenance and construction of the roads of Allegheny County, Pennsylvania. We have in that county 450 miles of improved roads. We have spent over $12,000,000 in the building of roads; in fact, we issue $1,000,000 of bonds each year, and then we have our maintenance or road tax, which yields us another $1,000,000. We are blessed in Allegheny County by having a high property valuation. The assessed valuation of Allegheny County is greater than that of three states (Maine, Connecticut and New Hampshire) put together; in fact, if we ranked as a state we would beat 13 states and 2 territories. The valuation of Allegheny County is $1,175,000,000, so you can see that we have no trouble in raising money to build roads. We can all build good roads if we have the money, so there is no credit due us for having them.

Eight years ago I was placed in charge of the maintenance department of our county. At that time the maintenance

department was a very small item in the road construction of that county, but the maintenance department has since outgrown the construction department. For six years I had charge, as I say, of maintenance, but still we had a sub-organization. There was the chief engineer who was in charge of the construction; he had a veto power. I was traveling along and he, of course, was watching what I did. Two years ago the first of next month, the county commissioners thought it would be advisable to consolidate the two departments and to have one head, and they selected me as the head of both construction and maintenance. After two years of service I can see that they made a mistake, and that mistakes are possible.

Mr. Carlisle says that, providing he has nine districts, he would then divide each of them into seven districts, making a total of 63, placing an engineer in charge of both construction and maintenance. Now, this is the part some of you men will not agree with me on. I say this is a mistake. It is a mistake in this way, and I am going to be broad in saying that over 50 per cent. of the engineers are good; but they are no good on maintenance. On maintenance you want the practical man; you want the man, if you can get him, that goes out with the pick and works his way up. The engineer has not had training for maintenance; that is not his trade. He goes to school, studies, graduates, and gets his diploma; but he has not rubbed up against the world, and does not know what it is to study human nature—as Mr. Bennett says, to slap the men on the back and say, "John, how are you this morning," and "How are you, Bill?" You have got to know your men; you have got to study them. One man you can go up to and damn him, and he won't quit; to another man you must go and pat him on the back and talk to him in a nice, gentle way, because he is sensitive and would quit on you if you rubbed him the wrong way. You have got to study your men. The engineer has had no training in the handling of men. He only knows how to construct the road.

If a man happens to lose his good wife and is left with three little children, you know he is in a box, because he doesn't know how to take care of them. The caretaker is gone; and if you want to know children you must know the mother. I am not the father of good roads in Allegheny County, but I have been the mother of them for eight years, and I know what it is to take care of them. (Applause and laughter.) You can put a nice road on paper; the engineer can draw you a nice road, and all of that. Just as Mr.

Bennett says, he likes to construct; he sees the finished road, and says, "Now, there is a fine road; see how nice it looks." Now, that is true.

Two years ago last August I was operated upon; the doctor said it was a very serious one, and his last instructions were, "Don't let him talk roads." Two mornings after the operation I waked up and alongside of me stood my nurse. I looked up at her and said, "Oh, Miss Alcorn, I am so tired; I can hardly lift my arms." She said, "What's the matter?" I said, "I was building a road; you ought to see it; I built a mile of the prettiest road you ever saw in your life." "Oh," she said, "tut, tut." I then said, "I did; I built a dandy road in my sleep."

You can build a road, a road that looks good; but I want to tell you the man who has charge of the maintenance of that road knows all about the weak points in it. The engineer goes along and puts in a 12-in. sewer, but you can't put in one that is too large. Now, the caretaker, sees these little weaknesses; he knows what they are; he knows that the engineer has made a mistake. It is the man who goes traveling around from one place to another that sees the mistakes. I believe in sub-organization; I believe in having a maintenance superintendent going from one district to another, and in that way he gets to see the good and bad points. He compliments the men on the good features, advising the other caretakers of them; and on the bad points he endeavors to set them right. I have always said that you can take a man with a pick and shovel, and, though he may not be able to read his own name, yet he can give the best engineer in the United States a pointer on some particular thing. And don't be narrow, men, because they give you that; take that pointer. Don't rob them of the idea; credit them with it; slap them on the back, and in that way you encourage them. Encourage a man to have good ideas and to give them to you, and don't ask your assistants to side with you simply because you are the boss. If you are wrong, have a general discussion regarding it; have them show you your error and then acknowledge it to them.

I make it a practice to talk matters over with my men. I have four division engineers and four assistant engineers. When I took charge of the department I called a meeting of all the engineers and said, "Now, men, when I was in charge of the maintenance branch of this county, some of you used to come to me and say, 'Now, on this road so and so did such and such a thing. Now, had I been in full charge I would have done this.' I want you men to feel that you

are a part of this organization; that it is necessary that we all put our shoulders to the wheel, as your work is an important part; and I want you to feel the responsibility that rests upon you." I brought out a general discussion on different topics; we were all benefited by it. This engineer had a certain feature which appealed to the others. This other engineer had a difficult proposition, and the opinions he got from the other engineers so helped him that he disposed of the matter in grand shape. Now, these little meetings are still held the last day of each month. I call the engineers in to my office and we take and discuss the various features incident to road building. When one engineer brings out a good point we acknowledge it to him, and in that way I find they are all endeavoring to get practical ideas and in that way gain recognition. That is what you need; you want the practical ideas. I was not even vaccinated as an engineer, so you couldn't expect it to take very well when I wasn't vaccinated; but I have acquired that experience by constant work. By giving one engineer charge of both construction and maintenance you are overloading him, because he is needed on construction.

All a contractor needs is horse sense; that's all he needs, or has got; if the engineer has horse sense he will get along with the contractor.

We have had the patrol system in our county since the first road was built, fourteen years, a patrolman to every 3 or 4 miles. In all, we have 120 caretakers. The district is small, smaller probably than one of your men would have.

When I go over to New Jersey I always envy Mr. Meeker. God must have loved New Jersey, because He made it level and gave them lots of gravel and lots of good stone with which to build roads. We have heavy grades in our county, the grading averaging a little over 11,000 cu. yds. to the mile. We have hills that give us a lot of work; and we have slides. Our caretakers keep the ditches and sewers open, remove all loose stone, keep all sewer heads, telegraph and telephone poles whitewashed, cut all grass and weeds, and we employ them the year round. Now, I have had many a good pointer given me by a caretaker—many a one—and I want to tell you that I always hit them on the back and say, "That's yours; it's good, and I am going to make use of it"; and every one is continually trying to get a new idea for Gillespie so that they will be given credit. When a man is wrong I jump on him; when he is right I pat him on the back and say, "Old man, your road looks good"; and you just bet he is always on the job.

Now, just a few words in conclusion on the bonding question. It was up yesterday, and I didn't have an opportunity to speak. Mr. Meeker mentioned that there is a great deal of opposition to issuing bonds for roads. I don't wonder. They say that the road is worn out and blown away before the bonds are paid. But it is not necessary that such should be the case. Mr. Meeker says the grading of the road is there, you can never lose that, and that, in our county, is 33 per cent. of the cost. The next thing on that road is the foundation—that is an important part. In traveling through any big city and looking at the big buildings being put up you see and learn that the foundation is an important part. Put down a good foundation and there is another 33 per cent. Then your top goes on. Your top may be blown away, that is true, but it is just the same as a man building a house. A poor man buys a little lot and he makes up his mind to put a home on it. He digs the cellar and carts away the dirt. The hole is there and will remain there until it is filled; so he has that much. Then he puts in the foundation, and he puts in a good one. He has that, then. He then puts up the house and places a mortgage on it; but before the mortgage is paid he finds he has to do some repairing; put on a new roof. He replaces the roof and he is all right. Now that is all, to my mind, that is necessary on the bond question; build your roads right and don't allow the foundation to get away. The old maxim, "A stitch in time saves nine," should be kept in mind. Put in that stitch in time; save your foundation and grading, and you have 66 per cent., and you will have that a hundred years from now.

Our roads in Allegheny County have the same type of foundation; we are using the same kind that we used 14 years ago. We then used an 8-in. telford base, and we still use it; and we find it is heavy enough for all the traffic we have to contend with.

Now, gentlemen, in bringing this to you I am not casting reflections on any engineer; I am patting him on the back, because his work is construction and not maintenance, for, as I have previously said, I believe in a maintenance man. Have your man, as Mr. Bennett says, associate more with the men under him and keep in touch with them. In going along our roads when I find one of our men working in a ditch I say to my chauffeur, "Toot your horn," and I call out, "Hello, Bill." I want him to know that I am on the job, that I found him at work; and it pleases the man. And then he will work all the harder, for he doesn't know but that Gillespie will be back that way. I carried a dinner

bucket, boys; I know what a kind word from the boss means, what it means to get a slap on the back from the boss. There isn't another branch of road building that is any more important than the maintenance branch, and there isn't another where money can be wasted as in maintenance.

As I said in the beginning, I have felt right along that our commissioners made a mistake when they consolidated the two departments, for I know that if I were more on the outside lots of money could be saved in the maintenance end. I am compelled to spend too much time in the office and do not have the opportunity to be in the close touch with maintenance that I formerly had. I thank you, gentlemen.

AUSTIN B. FLETCHER (State Highway Engineer of California):* The writer has read with much interest Mr. Carlisle's paper on state highway maintenance, particularly since he is now engaged in a study of the California conditions preparatory to recommending a plan for a maintenance organization for the California state highways.

As in the construction of the roads, no hard and fast rules can be laid down which will be applicable everywhere, so it is with the maintenance question. Conditions vary so greatly, even within the area of a state, that a treatment which may serve admirably in one locality will be of no avail elsewhere.

In California, as everywhere else, however, the maintenance problem, outside of the care of the roadsides, culverts and other appurtenances, is rapidly developing into the upkeep of bituminized surfaces of one kind or another requiring somewhat frequent applications of blanket or sealing coats of bitumen, and the maintenance outfits must be organized chiefly for that purpose.

The California Highway Commission has adopted for the major portion of the main trunk lines of the state highway system a pavement consisting of a concrete base covered with a thin coating of asphaltic oil of special quality combined with stone screenings or coarse sand.

These thin surfaces, under California conditions of climate, and traffic, are expected to last from two to four years before they require renewal, and outside of the roadside and shoulder upkeep, the wearing surface renewals will doubtless constitute the bulk of the work of the maintenance outfits.

The state was divided by the commission into seven divisions, each under the direct charge of a division engineer who reports to the State Highway Engineer. Attached to

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*Written discussion sent in but not read at the convention.

each division office is a corps of engineers, draftsmen and surveyors who are now engaged chiefly in the details of constructing the roads. As the maintenance work develops it is proposed to place it also under the charge of the division engineer, at least so long as the construction work continues under the bond issue of $18,000,000.

California is a state of magnificent proportions and some idea of its size may be had from the statement that the average area of the seven divisions is more than 22,600 square miles. When the state highway system, as at present financed, is complete, each division will have an average of about 425 miles of state highway in it, of which mileage perhaps one-half will have a bituminized surface.

While some of the roads will be in fairly thickly settled communities, the major part of the mileage will be in sparsely settled localities and often where there are no habitations for long distances. The theory of the state highways act is that the state is to construct the skeleton for the main lines of travel to which the counties will construct the "feeders" or "laterals."

The writer agrees that in general, taking into account the types of road now being built, a system for maintenance which relies chiefly upon patrolmen cannot be satisfactory. Such a plan for the upkeep of gravel, water bound or macadam roads has often been successful and the French organization is, of course, the most notable example. In California, however, in most places, such a system would be entirely inadequate on account of the great distances between towns and the difficulty of securing proper men for the work and housing and boarding them. Except for small patching and for small repairs on the shoulders and other minor work, a single patrolman could not do much effective work on roads with bituminized surfaces.

The writer agrees with Mr. Carlisle that the unit must be larger and in the nature of a "section gang" suitably equipped with motor trucks for spraying bituminous materials and for hauling and spreading the other materials used. The patrolmen may be used in some places on some kinds of roads, but to install such workmen generally on the California roads in charge of short sections would be neither an economical nor an efficient scheme.

In the writer's judgment the unit for such a division maintenance organization should consist of a competent superintendent who reports to the division engineer, with the required number of foremen, motor truck drivers, enginemen and laborers and with equipment sufficient to renew the

covering on about one mile of road per day. Such an outfit should be large enough to also take care of shoulder repairs, culvert cleaning, etc., at the same time.

Taking into account the California climate, the outfit should be able to work effectively not less than 200 days each year and one outfit in each division will probably suffice during the next two years.

The equipment for such an outfit, consisting of a motor oil distributor, two motor trucks, a self-propelled road roller, revolving street broom, small tools and sleeping and cooking arrangements, will cost not far from $20,000.

The work of maintenance on the California state highways is just about to begin. In November, 1913, there had been let to contract 365 miles of state highway, of which 268 miles are of the cement concrete type with the thin bituminous wearing coat.

F. C. PILLSBURY (Division Engineer, Massachusetts Highway Commission)*: Execution of the maintenance of the highways of any state, and particularly of the largest states, involves a great number of problems. In the smaller states there are problems sufficient in number to require great skill in execution, but in the larger states organization must necessarily, on account of its greatness, be much more complicated.

I think it is unwise to separate entirely maintenance from construction in any highway or street department. I use the word "entirely" because they must be separated to some extent, but just where the line may best be drawn depends upon local conditions. I mention this point, that is, the point where maintenance and construction begin to diverge in the organization, because so much depends upon placing it exactly right. The success of any undertaking depends largely upon the impetus it receives from the department head, and this department head, in order to be of the greatest efficiency, must be placed at just the right spot in the organization so that the lines through which he distributes his instructions and receives his information can be laid in just the proper directions back and forth; they must be if systematic organization is to be effected. Partial success is often mistaken for complete success for some time, but finally any system or organization proves itself. Of course, it is much better to start right when possible.

All highway organizations are subject to rapid growth and development, and wherever highway systems are fairly

*Written discussion sent in but not read at the convention.

well developed, as in a number of states, I think it is possible to arrange a form of organization which will permit of sufficient change to keep pace with future developments without demoralizing the force, or with a minimum of confusion. As I have already stated, there is no doubt that the size of the territory, volume of the work, mileage involved, topography of the country, etc., all affect the work to such an extent that any organization must be designed accordingly. A state with a territory comparatively small may be handled without construction or maintenance divisions, while the states of New York and Illinois, for example, would best be managed by dividing into certain districts not too large to receive a sufficient amount of personal attention from the head of the division organization, who may be termed the division engineer.

It is wise and necessary to place with such a division engineer a separate organization for maintenance, and another separate organization for construction, and that would seem to be the point of separation which I have before emphasized as being of great importance. Starting here, our discussion concerns only the subdivision of the maintenance department, and, while the division engineer should be qualified to advise and direct maintenance operations, he will not have time personally to attend to it, and this must devolve upon a superintendent of maintenance, who should be an engineer.

Maintenance work comprises everything that is involved on a road after it has first been constructed. The road after being finished returns to the state to be taken care of, and it finds its place in the maintenance department. The maintenance of a road commences as soon as it has been constructed and taken off the hands of the builder. It begins to wear out at once, and needs constant care and attention.

The work of maintenance varies widely. It consists of continual repairs to the road, constant watching to provide for the safety of the public, and replacing the wearing surface as well as any other parts that require renewal. If repairs are made as soon as imperfections develop, the life of a road surface is almost indefinitely increased beyond the period a road will last if it is allowed to exist without any repairs being made. The time always comes when it must be reconstructed, when the roadway must be widened, or other improvements made. All this work would naturally devolve upon the maintenance department, and the maintenance work, then, may be divided into two classes: (1) Ordinary maintenance, and (2) reconstruction. These words, I

think, are very descriptive, and should leave no ground for question as to what they cover. Now this divides the maintenance department into two subdivisions, if the area which is covered by the division is great enough to warrant it. Reconstruction is a difficult class of work. There is involved in it many problems which are akin to those found in original construction, and, unless the area of the division or volume of work is large enough to warrant a separate subdivision for reconstruction work, it should be turned over to the construction department for execution.

In my division I have, up to the present time, practically separated ordinary maintenance from reconstruction. This is on account of the fact that our reconstruction seemed to involve problems so different from ordinary maintenance that it required a special study, and the engineer whom I put in charge was able to make such a special study, and became efficient on bituminous reconstruction and on care of machinery, etc.

Much of our reconstruction has been done by laborers employed directly under our own foreman and on our payrolls. We had to do this, because we found contractors bidding were not sufficiently skilled in the new methods to do the work economically. This has proved very satisfactory, and may be recommended for comparatively small areas.

In our division we are obliged, in our ordinary maintenance work, to include the care of trees, sidewalks, and supervision of everything within the highway location, including underground and overhead public or private structures, and this has required a subdivision of the ordinary maintenance department.

The organization of the maintenance department in our division may be described as follows:

Ordinary Maintenance under an Engineer-Superintendent.

First Subdivision:

1. Assistant in charge of Permits, including supervision of all overhead and underground structures other than those pertaining to the structures of the Highway Commission on the highway itself. (Under this assistant are constantly employed one or more inspectors, who in number correspond with the volume of the work and are obtained by temporary employment, or by transfers temporarily from other departments.)

Second Subdivision:

1. An assistant, being an engineer, who has charge of special light oiling work, as well as giving assist-

ance wherever possible when he has the time, and when necessary.

2. Local maintenance foremen or repair agents, as we have called them, who have charge of from one to several different sections of roads.

3. Patrol gangs or section gangs, consisting of a single team, driver working with or without one or more helpers, in charge of stated sections of road, length varying according to the quantity of work.

4. Two or more special repair gangs doing the heavy repair work requiring the use of a steam roller, sprayer, etc. (These gangs are movable; they may do any work which would not require a regular reconstruction gang, and are moved to a road when its condition becomes so bad that the small section gang cannot put it in proper condition.)

Now, leaving the work in our division, which I have mentioned as an illustration because it has been in most ways successful, I would return to a general discussion of the subdivision of a maintenance department, and recommend a skeleton which may be adopted in part, or as a whole, or serve to furnish suggestions:

Division Engineer;
Engineer, Superintendent of Maintenance;
Engineer in Charge of Ordinary Maintenance;
Engineer in Charge of Reconstruction.

This subdivides the maintenance department twice.

Organization of the Ordinary Maintenance Department

1. Subdivisions in number according to volume of work, each in charge of an engineer, with such office assistants as may be necessary.

2. Each maintenance subdivision to have several foremen or road supervisors working directly under the sub-maintenance division engineer, in charge of several sections of road which are repaired by the small patrol or section gangs.

3. Small section gangs, consisting of a single team with driver, and, if necessary, one or more helpers.

4. Special movable repair gangs, a foreman, with a steam roller, sprayer, motor truck, and other machinery, as may be advisable, working directly under the head of the division maintenance department, and movable over the whole division.

Organization of Reconstruction Division of the Maintenance Department

1. Engineer in charge, with one or more assistants, being engineers, according to volume of the work.

2. Reconstruction gangs, varying in number, according to volume of the work, in charge of a foreman, with sub-foreman, timekeepers, laborers, machinery, etc., as may be necessary.

In common to the ordinary maintenance and reconstruction forces, there should be reporting directly to the engineer-superintendent of maintenance, a mechanical engineer, to look after all machinery, who might have charge of a centrally located storehouse and repair shop. Then there should be a supply clerk, preferably an engineer, to arrange and be responsible for the delivery of materials and supplies. At the office of the division engineer, there should be the necessary assistants, including bookkeepers, stenographers, etc.

There should be a complete system of bookkeeping, including provision for sending to the main office daily reports, on work done, materials and labor involved, condition of roads, with recommendations for work needed, etc. There should also be a proper system for ordering work and materials and keeping records of the same.

It is evidently impossible to allow any interference with this work, in its management as to detail, from any one above the division engineer, but it is wise if the highway department is of great size to have a system of universal auditing, whereby the accounts and methods of the maintenance department throughout the state could be examined frequently. This would serve as a check on the work, and keep the chief engineer or commissioners in touch with it and tend to eliminate carelessness that might otherwise, after a long time, develop.

Where there are large numbers of men employed, the success depends on the steady, regular machine-like performance throughout the system, provided its head is efficient and is not hindered in its work by so-called political conditions, or improper or ignorant influence, and this leads me to one more suggestion which I think is not out of place. It is absolutely essential to eliminate political influence from highway work, and particularly from the maintenance department. A civil service department is necessary for this, but the classifications should provide for highway engineers, highway foremen, and highway employees in general, rather than water works employees, or any other employees; that is, the civil service classifications should be brought up to date and made to apply to highway work.

Finally, there should be promotion for merit throughout the entire department, extending to the head of the department, and never should the head of the department nor the

commissioners themselves be appointed for any reason other than fitness. If the head of the department or commissioners are incompetent, how can we expect to obtain competence in the subdivisions of the organization, or anything other than demoralization, to a certain extent?

PRESIDENT HILL: Gentlemen, our distinguished Vice

President, Mr. McLean, has written me a short line, as follows:

Dear Mr. Hill:
The idea of a permanent committee on legislation has grown out of my own needs. Believing the recommendations of such a committee, approved by the association, would have a great influence on proposed legislative action, I suggest the following: First, a permanent committee on legislation, of five; that of course would be covering both Canada and the United States, first of all, to collect and make available, state and national laws; second, to make available a statement from which road authorities might obtain the desired information; third, to recommend proper features to incorporate in those laws.

Now gentlemen, I present that to you. The committee on resolutions of course has now passed away. Mr. McLean has been presiding here and has not had a chance to have his say. What is your pleasure in the matter.

[It was moved and carried that the Chair appoint a permanent committee on legislation.]

The Chair will announce that committee later. Now gentlemen, I have got to resign the meeting to Mr. McLean. Just one matter will take your attention a few minutes more. I am sorry to leave you, but I have an engagement.

CHAIRMAN McLEAN: Gentlemen. I wish to thank you for the action you have taken on this proposal. We cannot build good roads without good laws.

Before we adjourn I have been authorized by the President to call on Mr. George W. Cook to speak to you for three minutes. I will ask you to keep your seats until he is through.

GEO. W. COOK (President, Merrimac Valley Improvement Association): Except that I am going away, I would not presume on your attention. As President of the Merrimac Valley Improvement Association, this matter has interested me very much and I would like to present a subject which is germane to our work here—efficiency. We must have intelligent supervision of our road building and the maintenance thereof. Here is a field not overcrowded. Not every man who can use a pick and shovel can build a good road. Here is a little food for thought: If your boy shows a trend for this work, send him to a technical school or college to study civil engineering, then to this country and

Europe to study under the best road builders, and if he is worth anything at all he is good for $3,500 or $5,000 a year and is equipped to render excellent service to the people among whom his lot may fall.

I was asked by Congressman Shackleford, who spoke last night, to speak before his committee in Washington on the matter of federal aid. They want information and would welcome any communications you may see fit to send, if you cannot go in person. I assure you that the interest of every one of that committee is to do something for the people, to get at the best. There are many ideas and particularly as regards the units with which the United States should deal, and it would seem to me—it's only my personal opinion—that the smallest unit the government should deal with would be the states, and then the states, through their engineering corps, down to the cities and towns. I believe heartily in cooperation. The nation, the state, the city or town have vested interests and they will be seriously interested in working together and will get those improvements quickly.

The use of convict labor will solve many of our problems. We arrest a man and send him to the penitentiary or the workhouse and while awaiting trial he stays there sometimes a month, sometimes a year. He is taken right out of the workshop and put in there and kept in idleness. His muscles become lax, and even if he is released, when he comes out, he is a chronic loafer. If he is incarcerated there for a long period of time, he develops disease in various ways, and there is certainly nothing more healthy or more for his benefit than to send him out and put him to building roads. And it would not destroy his future, as has been suggested here, which I think is a most splendid idea. Let us make him a man and let him understand that if he runs away, it increases his sentence, and he won't run away. There are very few that cannot be trusted. Don't destroy his future, help him to be a man and save him. Follow the teachings and sentiments of the lowly Nazarene. Gentlemen, I thank you. (Applause.)

EIGHTH SSESION

Friday Afternoon, December 12

GEO. W. TILLSON (Third Vice President, American Road Builders' Association): Gentlemen, please come to order. The first paper for discussion this afternoon is entitled, "General Methods of Repairs and Renewals," by Mr.

A. W. Dean, Chief Engineer of the Massachusetts Highway Commission. Mr. Dean was obliged to leave this afternoon on the three o'clock train, consequently his paper will be read by Mr. Carl G. Richmond, Resident Engineer of the Massachusetts Highway Commission.

GENERAL METHODS OF REPAIRS AND RENEWALS

By A. W. DEAN

Chief Engineer, Massachusetts Highway Commission

Repairs and renewals of highway surfaces are matters of as great importance as the original construction—possibly greater, in that construction may be deferred for a period without serious loss, whereas repairs must often be made immediately when the necessity occurs. If a highway is properly built it will require very little attention for some time, but if improperly built repairs are called for immediately and renewals soon follow. A properly built highway is one properly designed to meet existing and anticipated traffic and other conditions, built with good quality of material and workmanship. Obviously, not every highway is or can be built properly, hence the problems of repairs and renewals are constantly before us.

Commencing at the foot of the ladder, so to speak, let us first give attention to the dirt road, of which there is a greater mileage than of any other single type. Apart from the bridges and culverts, the repairs on such roads may be made very largely by the use of a road drag, with the occasional use of a road machine. The drag is a comparatively new type of implement, but has been so widely advertised that it is perhaps not necessary to describe it at this time. Whether made of split logs, plank or steel, it is serviceable and should be used when the dirt is full of moisture, but not sufficiently so to be muddy. Frequent dragging will keep the average dirt road in good condition, and the road machine should be used only when it is desired to increase the width of section. Repairs and renewals are synonymous terms in this method of maintenance of dirt roads, in that every time a drag or road machine is used for repairs, the surface is renewed to some extent.

Sand-clay roads being essentially improved dirt roads, are repaired in much the same manner, but with perhaps more care. In addition to dragging, it becomes necessary to add more clay, or sand, or both, to strengthen weak spots that may develop. Renewals are made by adding to the entire surface, without previous preparation thereof, a layer of sand

and clay properly proportioned, and mixing same by harrowing.

Next in order of permanence is the gravel surface. So widely varying types of surfaces are described as gravel, that it might be well to limit the definition of gravel as material in which the mixture of round stones and particles is quite uniformly variable in size from minute particles to stones two or three inches in diameter. Repairs of gravel roads are frequently made, to some extent, by the use of the drag, but should not be made with a road machine except, as in the case of the dirt road, when it is desired to widen the traveled surface and sometimes to lightly smooth the surface. Whenever it is used for widening the traveled section, the material that is scraped from the sides should in no case be left on the road surface, but should be either carted away or thrown outside of the section worked. Renewals are made by simply spreading additional gravel over the surface without previous preparation thereof, and watering and rolling, if possible, but if not possible, permitting the traffic to compact the material.

Maintenance of a broken stone macadam road whenever constructed by the usual method (ordinarily termed as water bound macadam) is a more or less difficult problem, depending upon the traffic that it has to withstand. If the traffic is sufficient to wear out the surface rapidly and cause so-called "pot-holes" to appear, the practice of repairing or renewing it by adding stone without a foreign binder, is questionable. If, however, such traffic conditions do not exist, repairs are made by loosening the upper surface of the section to be repaired, adding broken stone of small dimensions, with sufficient stone dust to fill the voids, and compacting by rolling. Renewals are made by adding more stone to the entire surface in the same manner that the upper course of the road surface was originally constructed. If the thickness of the newly added surface is less than 3 ins. better results are obtained by loosening the old surface, reshaping and rolling it before adding the new surface. If, however, there is a thickness of 3 ins. or more to be added in the process of renewal, the old surface may be left intact and the new stone spread directly thereon.

The changes and development in the use of motor vehicles, trucks and tractors, make it appear advisable, however, in the repairs and renewals of macadam roads, to use a bituminous binder. This use of bituminous binder has become quite universal in many sections of this country during the last few years, and the problem of repair and renewal of bitu-

minous bound or surfaced highways, is gradually, through experience, becoming simplified. Repairs on a bituminous blanket or thin surface coat may be made by covering the section to be repaired with a thin coat of asphaltic oil or tar as the case may be, and immediately covering with pea stone, fine gravel or coarse sand. This is assuming that the repairs consist of renewing comparatively small sections of the coating that for any reason may have disappeared. No general fixed method can be described for making repairs due to imperfect workmanship, the use of too much bituminous material, or the irregular distribution of material, each case having to be treated in such manner as experience may have shown to be best. Renewals of bituminous carpets may ordinarily be made by a repetition of the usual process of constructing such carpets, except that it is advisable always to use less bituminous material per square yard for renewal than was used in the original carpet.

So-called sand and oil mixed road surfaces are either repaired or renewed by the addition of mixed material of the same quality and density as that used in the original surface.

Bituminous grouted or mixed macadam surfaces should not require early or frequent repairs or renewals if designed and constructed properly in the first instance. Should the necessity for repairs arise, however, they are ordinarily made by the removal of all disintegrated or imperfect portions of the surface, and substituting therefor a mixture of bitumen and small broken stone, the mixture being made either by mixing previous to application or by spreading stone and filling the voids by pouring. In renewing bituminous macadam surfaces it is not ordinarily necessary to break up or remove any of the existing surface, but the new surface may be added by spreading directly over the old surface. If, however, the old surface in addition to having become worn thin is worn very irregularly, it is advisable to loosen up, scarify, reshape and roll the old surface before adding the new surface material.

The repair of cement concrete surfaces is a comparatively new problem, as such surfaces have not been in use for many years, and such repairs as have been required have been due to imperfect workmanship or material. If the defects to be repaired consist of badly disintegrated sections, they cannot be permanently repaired except by the removal of all material in the sections to the full depth of the surface, and replacing same with new and proper concrete. If the defects to be repaired are minor, however, and consist merely of

small depressions, they may be repaired by filling the depressions with a bituminous mixture. When a cement concrete surface becomes worn sufficiently to appear to require renewal, it is impossible to renew same by adding a new thin coat of cement concrete mixture, therefore, it may be said that a cement concrete surface cannot be renewed with the same type of surface, but must be entirely removed and a new section constructed. This would be expensive, however, and it appears that the proper method for bringing up an old concrete surface is to cover it with a bituminous bound surface of some type, thereby creating a bituminous surface in place of a cement concrete surface.

Block pavements of all kinds can be repaired or renewed only by the entire removal and replacement of the sections to be repaired or renewed.

To go into details of all the methods for repairs and renewals of all types of surfaces would obviously require a document of much length, and the speaker has not attempted to cover details, but has merely presented enough material to bring out points that might lead to a discussion of the features of most interest.

CHAIRMAN TILLSON: It is hardly necessary to enlarge upon the necessity of repairs before a body of engineers or road builders. It is, however, said that some years ago a prominent city in this country sent its engineer abroad in order to find something that was permanent in the way of pavement. After an extended trip over Europe, he returned and reported that the only thing that he found that was permanent was repairs. (Laughter.) I think all of us appreciate that. The next formal discussion on this matter will be by Mr. Paul D. Sargent, Chief Engineer of the State Highway Commission of Maine.

PAUL D. SARGENT (Chief Engineer, Maine State Highway Commission): Mr. Chairman and gentlemen: In looking over the program for this meeting, I at once appreciated the fact that the program was very full, and having been invited to discuss Mr. Dean's paper, I proceeded to prepare a short written discussion which covers fully the points that I want to bring out, and I can present those points more quickly by referring to the paper than I can in any other way. So to save a little time so that we can clean up the balance of the program, I will present this short paper.

After several careful readings of the paper just presented it appears to the writer that this subject has been very thoroughly covered in a general way by Mr. Dean. One

or two points, however, will bear emphasis, and the speaker desires to call attention to them.

In the first place the speaker considers repairs and renewals of more importance than new construction; as has been stated, "construction may be deferred for a period without serious loss," but repairs and renewals can never be deferred without incurring loss which increases almost in geometrical ratio. The much quoted expression, "a stitch in time saves nine" seems to truly describe the need for prompt and intelligent attention to road repair and renewal.

Mr. Dean's definition of a properly built highway should be engraved on the mind of every official who is responsible for highway improvement. Were such the case, provided the definition were interpreted and applied with good judgment, repairs and renewals would not be of such importance in many cases as they are today. There are those I fear who think that a proper system of repairs and renewals will make up for deficiencies in original construction. To my mind, errors of judgment with respect to types of construction cannot be corrected through the medium of repairs and renewals unless we enlarge the term renewals so as to comprehend the complete replacement of the original surface by a surface of another type better suited "to meet existing and anticipated traffic and other conditions." From some points of view such replacement would virtually be an acknowledgment of lack of good judgment in connection with the original construction. As a matter of fact such replacement should really be termed reconstruction.

Dirt Roads: Due to the fact that dirt roads are ordinarily constructed without the use of a roller, depressions of greater or less area are frequently observed on their surface sufficient to hold water. This is particularly noticeable over culverts and at bridge approaches. The speaker believes that it is advisable sometimes to bring material in wagons for filling such holes or depressions and that the road machine or drag will not do this work satisfactorily. Otherwise he agrees with the ideas as to maintenance of dirt roads as set forth in the opening paper.

Sand-clay: In the renewal of this surface, as outlined, the harrowing should be supplemented by frequent dragging and smoothing.

Gravel: The speaker believes that his comments with respect to dirt roads are equally applicable in the repair and renewal of gravel surfaces and that the drag will be found very efficacious in securing a smooth and true section when resurfacing is done without the use of a roller.

Macadam: While this paper is devoted to "repairs and renewals" it may not be amiss to suggest that it is possible to maintain a water bound macadam road, even under quite heavy motor traffic, in a satisfactory condition, by keeping the surface covered with a light cushion of sand or pea gravel. Once this cushion is applied it may be kept in place by using a combination drag and brush harrow similar to those used in smoothing race tracks.

On the statements with respect to other surfaces the speaker is in accord with the ideas set forth in Mr. Dean's paper. One fact which is not stated in so many words, but which may be understood by inference and should always be remembered, is that in repairing a properly designed surface, where traffic conditions have not changed, the same material should be used as was used in the original construction.

CHAIRMAN TILLSON: The next formal discussion on this matter will be by Mr. A. D. Williams, Chief Road Engineer of West Virginia. Mr. Williams.

A. D. WILLIAMS (Chief Road Engineer of West Virginia): Gentlemen of the Convention: I did not prepare a written paper, because I had the knowledge that other papers would precede me; therefore, I did not feel like duplicating, and what I shall say will be said from experience, and briefly and to the point. In the first place, I feel that in all of our discussions in gatherings of this kind, we give too much time and lay almost too much stress upon the construction and repair of the roads and the streets in the most populated districts. We give but little attention to the roads back in the country districts.

I feel impelled to deviate a moment: Last night we heard a criticism of the engineering profession that reminded me of a story. The distinguished speaker referring to the engineers not being financiers and able to design and construct work so as to be economical, brought to my mind an incident that transpired down in Virginia, just across the line from my home state. An old darky was accused of stealing chickens, and while on the stand it was brought out in cross-examination by the witness who was accusing him that he possessed a large dog and that no one could enter the yard while that dog was in there. After this was brought out the judge turned to the darky and said, "See here, Bill, explain to me how it was that you could enter that yard and steal those chickens with that kind of a dog loose in the yard?" The old darky looked up and said, "Please, Mr. Judge, you's a good judge, you knows your business as a judge, and I believe it would be a good thing to stick to that

job. It wouldn't be necessary for me to tell you how I got into that yard, because I don't believe you've got sense enough to know how to steal chickens." (Laughter).

A great deal of time and energy is wasted in criticising our professional men and not in talking on the questions at issue. I believe, as was stated here this morning, in practical men—we all do—but at the same time, gentlemen, believing in practical men is not believing that a man having been trained in a university and having devoted his life, time and thought to any one thing is thereby made impractical. If so, where will you get a professional man?

This is best illustrated—if you will pardon—from my own experience as a boy on the farm. One morning an associate and I started out with scythes. I was in too big a hurry to grind my scythe; he took time enough to grind his. We went out into the field and mowed side by side during the day. He had to whet his scythe but little during the day and I put in a good deal of time whetting mine and my arm was tired from whetting it throughout the day. When night came I was behind him, practically worn out while he was feeling good. One was your practical man with preparation; the other, unprepared.

Now the reason we have not had a success, as we might term it, from college men, in dealing, we might say, with the minor problems of road construction, is because there has not been a demand for a concentrated study of the problem. But the demand is here and the universities will meet it. In many instances we have overlooked the real, practical end of the work in our training schools. This can be offered as a proper criticism.

I feel like saying that there is not today an engineering book written on road work that gets down and deals closely enough with the practical problem, much as is now being written in our road journals. I would like to suggest that men who have given practical study to this question get down to earnest work and help to put in form for those that go into the schools these practical ideas. This convention has seemed more practical to me than any road convention I ever attended for we have gotten to the meat in the cocoanut.

I am not going to take up further time speaking to that phase of the subject, because I want to speak for just a few minutes on the conditions that confront us on the back country road. Here lies our problem: In the first place, we must consider the amount of money we have available with which to build and repair roads. I call to mind now one district in one county in my state wherein we have 80

miles of road and an available sum of $275 with which to keep that road in repair and make necessary changes. Such conditions are confronted in many rural districts; therefore, we cannot lay down a general method of repair, but must meet the general financial conditions of the country districts, and adapt our methods of repair to three things.

First, to the kind of road to be repaired; second, to the class of territory in which we are making the repairs, and the materials that are available; and, third, to the amount of money available without placing a burden upon the people. With these we can put a road in shape to meet the demands of that district, but we must not forget that the roads of one district affect people in another.

Now I do not believe that at all times it pays to expend a great amount on the repair of certain roads in mountainous districts; it is better to abandon that particular piece of road, especially if there are hard grades, and apply that money, or part of it, in making the necessary changes so as to get better results. It is impossible, on high grades, to maintain a dirt road; water conditions are to be contended with. The steeper the grade, the greater the velocity of the water and the harder the road is to maintain. That being true, we must provide first, to get the water from the road as quick as possible, and to get it so that the high velocity of the water will not cut away the surface of the road or by being too much weight in the ditch cut in on the sides of the road.

Nothing that enters into road repair work is more important than the question of drainage. Here again we meet a problem. A number of districts are not able to build suitable drainage; they do not have money to build the proper culverts, but I wish to offer here a solution for some of this difficulty; that is, to put in a drain that will take care of the water under ordinary conditions, and then construct an overflow culvert that will let the heavy water pass over without destroying your roadbed. This can be done by constructing a wall on each side of the road and filling the center with stone or material that will not wash. I remember last year, in one section of the state, we had 5 ins. of rainfall in less than two hours. It is not practical to design drainage to suit such conditions at a cost in reach and reason, especially when we take into consideration elevations ranging from 600 ft. above the level of the sea to 4,800 ft. The velocity of the water coming in from these slopes often makes conditions that cannot be foreseen. It is necessary, then, to provide some kind of emergency drainage that will meet the demands and yet be within range of the finances of the district.

Gentlemen, I will not take up more of your time to discuss other phases of the subject, because the gentlemen who preceded me have covered it admirably, and other papers are to follow. I wish to thank you. (Applause.)

CHAIRMAN TILLSON: The next gentleman to present a formal discussion on this matter is Mr. Robert C. Terrell, State Commissioner of Public Roads of Kentucky. Is Mr. Terrell present? If Mr. Terrell is not present we will proceed to the next paper, which is by Mr. H. G. Shirley, Chief Engineer of the Maryland State Roads Commission.

H. G. SHIRLEY (Chief Engineer, Maryland State Roads Commission): The general repairs and renewals of earth roads are as described in the opening paper on this subject, but very often the earth roadbed is broken full of ruts and holes and has a very uneven surface. In this case the method pursued by the speaker—which has worked very satisfactorily—is to plow up the entire surface, from gutter to gutter, then shape it with a road machine and keep it constantly dragged until it has become hard and compact. The speaker also wishes to concur with the former speakers regarding the necessity for constantly dragging earth roads in order to keep the surface in repair.

There is another type of road, similar to the earth road, to which the former speaker did not refer, and of which my state has a number of miles, namely sand roads.

Sand Roads: The repairs and renewals of this type of road consist in filling up the chuck holes, dragging in the ruts and keeping the surface level without any cross sectional slope. These roads rut easily, and are at their best after a heavy rain. The flat cross section is used in order to hold the moisture as long as possible.

Sand-Clay Roads: In repairing sand-clay roads the best results have been secured by applying the sand when the roadbed is moist or wet, and clay when it is dry and easily pulverized and can be uniformly spread. On the soft spots which show an excess of clay, and where the sand has been blown off or washed away, a sufficient amount of sand should be added, so that when it is worked into the clay a stiff and hard mixture will be secured. Where a patrolman is located on the road the surface is being constantly renewed by the addition of sand and clay where the surface has worn thin, and this practically keeps the road in the same condition as it was when it was first built. Constant dragging is necessary on this type of road to keep the surface smooth and in shape, and the speaker has found that a heavy drag gives better results than a light one

Gravel Roads: Repairs on a gravel road can be made to greater advantage early in the spring, before the moisture of the roadbed has been absorbed by the long hot days of the summer. Especially is this true if the gravel contains a large percentage of sand and a small percentage of clay, and where the surface has not been laid by watering and rolling. Dragging is absolutely necessary in this character of construction, in order to keep the ruts filled, as well as to maintain the proper cross section.

Water Bound Macadam: The manner in which repairs should be made to water bound macadam roads depends largely upon the amount and character of the traffic passing over them, as set forth in the opening paper. If the traffic is all horse-drawn, steel and iron tire traffic, it will only be necessary to loosen up the old surface adjacent to the hole and apply enough stone to just fill the hole after it has been thoroughly tamped. Renewals, under similar traffic conditions, are made by scarifying the surface of the road and adding three to four inches of new material of good quality to it and then thoroughly rolling and watering the surface until it is compact and hard.

In repairing a road which was built or treated with a bituminous binder, all depressions should be filled in with a mixture of bitumen and stone, great care being taken not to use too much bitumen, as the patch will work or push about. After the patch has been made it should be covered with "pea" size stone or gravel. The speaker believes a surface treatment or squeegee coat should be applied to all bituminous macadam or bituminous concrete just as soon as the surface shows a slight amount of wear and the stones show signs of loosening. Repairing and renewing the surface with bituminous materials can be successfully done on any hard surfaced road. The speaker treated a badly worn shell road in the eastern part of his state in the following manner:

The traffic on this road consisted almost entirely of one or two-horse teams and motor traffic. There were three longitudinal depressions in the surface, one in each wheel track, and one in the center which was badly dug out by the horses. The road was swept as clean as possible, a motor truck with a pressure distributor being used to apply the tar. All the nozzles in the distributor were closed, except those which were just over the depressions. About one half of a gallon of tar to the square yard was applied. This application was immediately followed by a large gang of laborers spreading stone from ½ in. to 1 in. in size until the depressions had been brought up to the proper cross

section. Great care was taken to see that all the depressions were filled with stone and the road had a true cross section. After all the depressions had been treated in this way and the tar had set up, the entire surface was treated with an additional half gallon of tar and covered with stone chips. The cost of this work was small compared with what it would have cost to resurface the road with shells, and the wearing power is very much superior to shells.

Concrete Roads: The former speaker covered the subject of repairs so well on this type of road that I can add but little, except to say that small patches should be made with a tar, while renewals can be made with an asphalt, provided the thickness of the surface applied exceeds 1 in.

Block Pavements: Block pavement can be repaired by either reversing the blocks or by adding new blocks to take the place of those worn.

To renew this type of pavement, it is necessary to replace the entire surface, or patches, with material similar to that used in the original construction.

The subject of repairs and renewals having been thoroughly discussed, the speaker wishes to call attention to the personnel of this subject, as it is well known that the men who do the actual work along this line are of a most ignorant type, having practically no knowledge of the reasons for doing the work in the manner in which it should be done, and only carry out the instructions of the inspector or resident engineers as they interpret them. These interpretations are sometimes along the right lines, but more often they are along the wrong lines. I, therefore, believe that it would mean many dollars saved, the cost of supervision greatly reduced, and better results obtained if the road departments of states and counties would devote more time and attention to the teaching and training of the patrolmen and caretakers of their roads.

CHAIRMAN TILLSON: Mr. Terrell's paper has been handed in and I will ask Mr. T. A. Hulbert, Associate Editor of "Good Roads," to kindly read it.

R. C. TERRELL (Commissioner of Public Roads of Kentucky): In discussing the general methods of repair and renewal it is impossible to separate them from maintenance. If the proper repairs are always made to the road surface they will constitute constant maintenance, while renewal of the road surface constitutes periodic maintenance, and in most instances a combination of the two is probably the most effective.

Mr. Dean's paper takes up the general types of surfaces

and his discussion concerning earth roads is worthy of note. It should be borne in mind that by far the greater portion of our roads now consist of, and for a long time to come will consist of earth as surfacing material, and unless the earth road is given more consideration and more thought the traveling public will of necessity suffer heavily. It is well and proper that the more expensive types of road should be given due consideration, but if the earth road is as much neglected in the future as it has been in the past it will cost the traveling public much more than the more expensive types.

I thoroughly agree with Mr. Dean in his approval of the split log drag. The drag, if properly operated, will do a wonderful amount of work, but usually the road drag enthusiast expects it to move the earth in a minute, and when it fails to come up to his expectations he not only discards it but discourages its use. It is well to mention here that while roads can be built by use of the drag, the process is slow and tedious. It is properly a tool for the repair and renewal of the surface after the surface has been properly formed by the use of road machinery.

A selection of gravel for repair or renewal is a matter which should be given careful attention, as gravel that does not contain enough binding material will remain loose on the traveled roadway for quite a long time and will eventually spread out to the gutters or rut to such an extent that it will be of little use. If proper results are expected from the renewal of gravel roads, the same care and attention must be given this type as is given the macadam road. It is well here to emphasize Mr. Dean's statement that if possible the surface should be watered and rolled before being thrown open to traffic.

Broken stone roads may be repaired with fairly satisfactory results when the so-called pot-holes occur, provided the hole is cleaned out so as to have vertical edges, and stone of approximately the same size as that comprising the original macadam is used. Each layer should be thoroughly tamped and the last course brought to the same elevation as the surrounding surface. It is not advisable to make patches in water bound macadam with other than the same character of material as the surface of the surrounding road. In fact, it has been conclusively proven by practice that the best results are obtained from surfaces of even texture and wearing capacity. However, in renewing the surface of a water bound macadam road due consideration should be

given to the amount of automobile traffic that it is expected to sustain, and if this amount is excessive it will probably be found economical to use some type of bituminous surfacing material. And in this connection I wish to call attention to the Kentucky rock asphalt which is found in large quantities in the central portion of the state of Kentucky and which can be quarried, crushed and shipped a distance of 500 miles or more and placed on the roads at a cost that is surprisingly low. And if properly placed, it will not only be found to be low in first cost, but also very easy to maintain, calling for very few repairs and seldom requiring renewal.

Renewing the surface of brick roads requires a complete re-treating of the surface by either turning the brick or, if too badly worn, by replacing with new brick on a newly shaped sand cushion. In the case of concrete roads, if the surface becomes very badly disintegrated it will be either necessary to place an entirely new coating of concrete or patch the worn-out places with tar or other bituminous material, which is not always satisfactory. Since a brick road requires a concrete foundation it is probably wise to start in by building a concrete road and when the surface begins to disintegrate slightly to place a sand cushion on the concrete and surface it with brick. However, concrete has not been sufficiently tried to determine whether or not it will last, when properly constructed, as long as brick.

It will be necessary for the engineer to determine after proper investigation of the local conditions which character of surface will be the cheaper and which class of construction will last the longer and give the best results.

I have endeavored to discuss only the points brought out in Mr. Dean's paper and have confined my remarks strictly to the point. Much can be said if details are considered, but in general the details of the treatment of repair and renewal of road surfaces have been discussed at such lengths in other papers that it is hardly necessary to repeat them here.

CHAIRMAN TILLSON: The next gentleman to discuss this paper formally is Mr. B. Michaud, Deputy Minister of Roads, Quebec, Canada. Is Mr. Michaud present? If not, the discussion is now open to the house.

As there is no discussion on this subject, gentlemen, we will proceed to the next subject on the program, which is "Bituminous Surface Treatment and Dust Prevention," a paper by Mr. Wm. H. Connell, Chief of the Bureau of Highways and Street Cleaning, Philadelphia, Pa. (Applause.)

WM. H. CONNELL (Chief, Bureau of Highways and Street Cleaning, Philadelphia, Pa.): Mr. Chairman and Gentlemen: When I was assigned to read a paper on "Bituminous Surface Treatment and Dust Prevention," I gave a little thought to the matter and came to the conclusion that we have, in the past few years, learned a great deal on this subject, and we have at least learned enough to assume that certain fundamental principles have been established. And I decided, that, in the matter that I am going to present to you it would not be a wise policy to repeat these fundamental principles.

We know that a road must be thoroughly cleaned, and we know that it must be thoroughly rolled and perfectly hard and in fit condition in other ways to receive a bituminous surface treatment. In the past I feel that a great many of our papers have started out by repeating all these principles that I refer to and that we are all well acquainted with; and those that are not well acquainted with them have ample opportunity, by referring to articles written on this subject in the past, to become familiar with the proper method of taking care of a road preparatory to putting on the bituminous surface treatment.

I have made it a point, as far as possible, in this paper, to avoid repeating what has often been said. I am going to be so bold as to say that in all engineering papers that are written, not only on this subject but on other subjects, there is a great deal of unnecessary repetition. A man will read a paper who is working, for example, on bituminous surface treatment, and he will describe his experience and state how the work should be done to insure a successful treatment. He, after a while, passes to the rear, because we have all heard what he has to say, and the principles—the main points in his paper—have become generally accepted, not through him, but through the experience of numerous others engaged in the same kind of work, and it is decided to have some new man read a paper on the same subject. The new man very often presents a paper on the same subject, covering the same ground that has been covered two or three years previously. I think that we would all make much more progress if, when we are requested to read a paper, we make it a point to look over previous papers that have been read and try, as far as possible, to avoid repeating those fundamental principles in connection with the particular subject that are acknowledged to be present-day standards. With this in view, I am going to read a paper somewhat along those lines, and give you a little

synopsis of some of the work of this character done in Philadelphia. The second division in this paper that I am going to just touch upon covers a phase of the subject that has not been given the attention it deserves. The subject should embrace the care, through bituminous surface treatment and dust preventives, of city pavements, as well as country roads, as all highway engineers have a certain amount of city pavement as well as country road under their jurisdiction.

BITUMINOUS SURFACE TREATMENT AND DUST PREVENTION

By WM. H. CONNELL
Chief, Bureau of Highways and Street Cleaning, Philadelphia, Pa.

Bituminous surface treatments and dust preventives should be divided into two main divisions, each with a sub-division, and for convenience they will be classified as follows:

1. Bituminous surface treatment designed to waterproof and act as a wearing surface on water bound macadam, gravel, shell, slag, and dirt roads.

1-a. Dust preventives for water bound macadam, gravel, shell, slag, and dirt roads.

2. Bituminous surface treatments designed to waterproof and rejuvenate old bituminous pavements, sheet asphalt, asphalt block, and wood block pavements, and to be used as a wearing surface on concrete and old brick pavements.

2-a. Dust preventives for standard types of pavements, commonly used in municipalities, such as ordinary water sprinkling, washing with squeegees, and flushing. (For convenience, in this paper "bituminous pavements" will refer to pavements consisting of stone, or stone and sand mixed with a bituminous binder, built by the penetration or the mixing method.)

The first classification applies more generally to country roads and the second to town and city pavements. There is so much overlapping, however, in the handling of these respective classes of highway work, that a highway engineer should be familiar with all branches of highway work in connection with both roads and pavements, and it is therefore desirable to take this subject up as a whole rather than confine it to country roads.

The use of bituminous surface treatments and dust preventives on country roads has now become so general that there is no longer the mystery attached to the respective merits of the bituminous materials and dust preventives in

general use that has existed in the past; in fact we have reached the point where there are more or less standard methods of treatment for the different types of roads, and, by making a careful study of the condition of any road, it is not difficult to determine upon the best available treatment suited to the road in question, based upon former treatments of similar roads under like conditions. So, as far as the materials in general use are concerned, we can get a more or less satisfactory treatment for all classes of macadam, gravel, dirt, and shell roads, but we have by no means reached the point where we have an ideal treatment for such roads. We have, however, reached the point where there is no necessity for extravagant waste in connection with our surface treatments, and going on the theory that an ounce of prevention is worth a pound of cure, it is far better to employ expert advice in connection with work of this character than to have inexcusable and disastrous failures due to the use of bituminous materials not adapted to the conditions, or the conditions not being satisfactory for bituminous surface treatment. The principal cause of the numerous failures is that there is too little attention paid to this phase of the situation and, as a matter of fact, it is just as necessary to employ expert advice in connection with this work as in any other branch of engineering work.

New materials and methods of treatment resulting from laboratory experiments and research work should be developed through experiments on sections of roadway of sufficient length, rather than through wholesale use, which may or may not result in a failure, and in fact more often does result in a failure on first trial. There have been numerous papers and discussions on the subject of bituminous surface treatments and dust preventives in the past five years, and while there were wide differences of opinion concerning the respective merits of the available bituminous materials and dust preventives and the proper methods of treatment in the early papers on the subject, a review of the papers written by recognized authorities within the past two years shows that in so far as the treatment of country roads is concerned there is little, if any, difference of opinion concerning the underlying principles that should govern the selection of materials and the preparation of the road for surface treatment. This being the case, a great deal of repetition can be avoided and a better understanding reached by formulating standards relating to the elementary principles of the selection and the use of bituminous surface treatments and dust preventives for country roads. This will result in stimu-

lating scientific research, and the development of new thought in the other phases of this all-important subject, namely, the bituminous materials which are shrouded in so much mystery, due in part to trade conditions, and in which the advance has not been commensurate with the possibilities in the past two years. We are face to face with this problem and our progress within the next few years depends upon bettering the bituminous materials and dust preventives now in use. As it is assumed that you are all familiar with or have read articles by recognized authorities covering the underlying principles relating to the selection and application of bituminous materials and dust preventives on different types of country roads, this phase of the subject will close with the following summary of work of this character done in Philadelphia during the past year.

During the year 1913 the Bureau of Highways treated 415,000 sq. yds. of water bound macadam with various tars and asphalt cut-backs, at a cost of 4.9 cts. to 10 cts. per sq. yd. The high cost for some of this work was due to several reasons. First, the work was widely scattered throughout the entire city, and in a large number of cases only consisted of one or two blocks, making it very expensive to move the gangs and equipment from place to place; second, lack of experienced men to handle the work, and third, the high cost of suitable top dressing available in this locality. The material used was a torpedo sand passing a ⅜-in. screen with not over 10 per cent. passing a No. 20 sieve, which cost from $2.50 to $2.75 per ton delivered on the road, which is also the standard price for clean trap rock chips in this locality. The labor cost for sweeping and chipping ran from .70 ct. to 3.60 cts. per sq. yd., and chips and gravel from 1.8 cts. to 4.6 cts. per sq. yd.; bituminous materials from 1.3 cts. to 4.5 cts. per sq. yd., applied. The cost of the bituminous material was as follows: Tarvia A, 8.5 cts., Tarvia B, 7 cts., Ugite 1-C, 7 cts., and Ugite No. 3, 8 cts.; asphalt cut-back, 12 cts. per gal., applied.

Realizing the importance of cleaning the macadam thoroughly before applying the bituminous material, both hand and machine brooms, as well as scrapers, were used, care being taken to remove all dust and dirt so that the stone was absolutely bare, after which the bituminous material was applied in quantities of from ⅛ to ½ gal. per sq. yd. Wherever possible the road was blocked off and the material allowed to penetrate for a matter of 24 hours before chipping. If traffic conditions would not permit blocking the road for this period of time, it was chipped before stopping

work for the day. The quantity of chips applied averaged from 13 to 34 lbs. per sq. yd., depending upon the amount and character of the bituminous material used. Every effort was made to avoid creating a pad on the macadam surface, especially on heavy grades. Where the bituminous material was applied during cold weather very little, if any, penetration was secured, which resulted in a thin pad. Several old tar penetration sections were treated with a light application of about ¼ gal. per sq. yd. of tar and then chipped, which in most cases has put the road in good condition and will undoubtedly lengthen its life for a period of a couple of years.

The asphalt cut-back consisted of 65 per cent. of asphalt with a penetration of 140 to 160 at 77° F., cut back with 35 per cent. of commercial naphtha with a gravity of 53 to 55 Beaume. This was applied in quantities of from ⅓ to ½ gal. per sq. yd: The naphtha acted as a carrying agent and in most cases a penetration of about ¾ in. was obtained, depending upon the temperature. The material was applied cold, and in some cases the material was fired immediately after the application, burning out the naphtha, which resulted in an immediate set in the asphalt; and up to the present time the results have been very satisfactory. The results obtained from the various tars used have been very satisfactory with the exception of a few sections which were applied late in the fall and which, we believed, contained too large a percentage of asphalt in the tar, causing very mucky condition after each rain.

The primary consideration pertaining to the application, all other conditions being satisfactory, was to avoid a pad, the object being to waterproof the surface of the roadway and use just enough material for this purpose so that the surface would wear off uniformly and be in condition for a new application when necessary, instead of having it creep and pit in spots, which is often the case with a bituminous pad and which is very difficult to satisfactorily repair. The selection of the bituminous materials used in each case was governed by the fundamental or underlying principles covering this phase of the subject.

The tar treatments were applied hot and cold under pressure, depending upon the material used. In the case of the material applied cold, about ⅓ to ½ gal. per sq. yd. was used, while in the case of the hot application from ¼ to ⅓ gal. was used. The cost of the cold application of tar averaged 6.7 cts. per sq. yd., while the hot application averaged 8.7 cts. per sq. yd. These costs are high, notwithstanding the high

cost of top dressing in this locality, due to this class of work being new to the organization performing the work.

Other materials used were Glutrin, which was diluted by adding 50 per cent. of water and applied at the rate of ½ gal. of this mixture per sq. yd., and calcium chloride, and asphaltic oil, of about 18 to 21 Beaume gravity, applied at the rate of ¼ gal. per sq. yd. These two latter materials were used simply as dust layers.

With regard to the vast field coming under the head of the second division, or the division covering the more permanent types of pavement, little progress has been made in treatments designed to waterproof and rejuvenate old sheet asphalt and such types of pavements, except possibly in St. Louis, Mo. It is far from exaggeration to say, however, that large sums of money (resulting from prolonging the life of, particularly sheet asphalt and asphalt block pavements) can be saved by suitable surface treatment on old pavements of this type requiring such attention. The same can also be said of old bituminous pavements built either by the penetration or mixing method, and a great deal of work of this character has been done in Philadelphia this year. Considerable experimental and research work, however, has been carried on in connection with bituminous surface treatments on concrete throughout the country without entirely satisfactory results. The following experimental bituminous surface treatments on concrete have been laid on the Service Test Road (Byberry and Bensalem Turnpike) this year:

Section 3, Station 47+00 to Station 50+00.

One-half gallon per square yard of Pioneer Road Surface Asphalt was applied at a temperature of 350° and covered with clean trap rock chips passing a ⅝-in. screen and rolled with a 6-ton tandem roller.

Section 5, Station 52+50 to Station 59+50.

From Station 52+50 to Station 54+58 a bituminous top of Ugite was applied. After sweeping the surface of the concrete, 1-6 gal per sq. yd. of Ugite A was applied by hand and ⅝ gal. per sq. yd. of Ugite No. 3 was then applied at a temperature of 280°, by a pressure distributor. A coating of ¾ in. dry trap rock chips followed. Another application of ¼-gal. per sq. yd. of Ugite No. 3 was then applied at a temperature of 280° by a pressure distributor, which in turn was covered with torpedo sand and rolled with a 12-ton three-wheel roller.

From Station 54+58 to Station 57+17, a bituminous top of Tarvia was applied. After sweeping the surface of the concrete, ¼ gal. per sq. yd. of Tarvia B was applied cold, after which ⅝ gal. per sq. yd. of Tarvia A was applied at a temperature of 250° with a pressure distributor and covered with torpedo sand.

From Station 57+17 to Station 59+50, a bituminous top of Texaco Asphalt was applied. After sweeping the surface of

the concrete, ⅛ gal. per sq. yd. of Texaco Asphalt, cut-back with naphtha, was applied by hand, after which 0.6 gal. per sq. yd. of Texaco Asphalt, 55 penetration, was applied by hand at a temperature of 450° and covered with clean trap rock chips passing a ¾-in. screen and rolled with a 12-ton three-wheel roller.

Section 9, Station 87+50 to Station 94+00.

From Station 87+50 to Station 92+00, a bituminous top was laid.

From Station 87+50 to Station 90+00, 0.4 gal. per sq. yd. of Dolarway bitumen was applied at a temperature of 207° and covered with torpedo sand.

From Station 90+00 to Station 90+70, ⅛ gal. per sq. yd. of Bicomac was spread on the surface of the concrete pavement. A mixture of trap rock chips, trap rock dust and Bicomac was then applied and rolled with a hand roller. One-half of this surface was covered with trap rock dust and rolled lightly. The other half was covered with trap rock chips and rolled lightly.

From Station 90+70 to Station 91+35, 0.4 gal. per sq. yd. of asphalt cut-back with naphtha was spread upon the surface of the concrete pavement and the naphtha was burned out. Trap rock chips were then spread and rolled into this asphalt coating with a hand roller.

From Station 91+35 to Station 92+00, ⅛ gal. per sq. yd. of Bicomac was spread upon the surface of the concrete pavement, after which 0.4 gal. per sq. yd. of asphalt was applied at a temperature of 400° and covered with clean trap rock chips passing a ¾-in. screen.

Section 14, Station 112+50 to Station 118+00.

One-fourth gallon per sq. yd. of Ugite No. 3 was applied at temperature of 250° by a pressure distributor, which was covered with clean trap rock chips passing a ½-in. screen and rolled with a 6-ton tandem roller, after which ¼ gal. per sq. yd. of an asphaltic cement was then applied at a temperature of 425°, by a pressure distributor, and covered with clean trap rock chips passing a ½-in. screen and rolled.

For further particulars see the report on the Service Test Road.

In this connection it might be well to state that thus far, from the experience in Philadelphia, where naphtha is mixed with an asphalt of about 60 penetration, it is necessary to add about 50 per cent. of naphtha, gravity 53 to 55, to create a bond with the concrete.

The methods used to do away with the dust nuisance on the more permanent types of pavement are thorough cleaning, preferably washing with squeegees, flushing with pressure flushing machines or hose. The field for the class of work coming under the subject of this paper and covered by the second division has been only lightly touched upon in this paper and, as a matter of fact, has not, generally speaking, been given the attention throughout the country that it deserves, excepting bituminous surface treatments on concrete.

In conclusion, it might be well to add, that after all is said and done we only too often have to cut our cloth according to our pockets and cannot always use the type of bituminous surface treatment and dust preventive we prefer; but, even so, there is such a thing as doing the best we can under these conditions, and if whatever may be done is the result of careful consideration, embodied with personal knowledge on the subject or advice from some recognized authority, conditions can always be bettered.

CHAIRMAN TILLSON: The next formal discussion on this paper will be by Mr. C. W. Ross, Street Commissioner of Newton, Mass. Mr. Ross is not present but has sent in his discussion, which will be read by Mr. Hulbert.

C. W. ROSS (Street Commissioner, Newton, Mass.): The two problems that confront the road builder of today are the prevention of dust and the conservation of previously constructed roads from wear and disintegration.

Many materials have been tried but among those successfully meeting the tests are Tarvia, Asphaltoilene, liquid asphalts, coal tar, Terracolio, Tarine, Ugite, calcium chloride, Dustoline and Tasscoil.

For the more permanent work, Portland cement, liquid asphalt, and many of the newer preparations that have been put on the market within the past few years, while appearing expensive, will prove in the long run actually cheaper in dollars and cents, because they will provide a much more satisfactory road to travel on and the necessity of resurfacing every two or three years is obviated.

It is obvious that some of the heavier bituminous, asphaltic or cement treatments should be incorporated into the top surface of a road if it is to be resurfaced with from 2 to 4 ins. of new stone. These preparations may best be incorporated into the surface of the road by forcing them in under pressure, filling up the interstices of the stone and making a fairly rigid surface. After these preparations have been applied, if the top shows a tendency to become dusty, it is imperative that the road be treated with a heavy asphaltic oil or bituminous preparation, which should in all cases be applied hot.

I would suggest that where possible only one-half of a street be treated at a time, leaving the other side open to traffic.

Without any doubt, the time has come for a decided change in the method of constructing streets. The old style of macadam roads will not meet the test of the constantly

increasing automobile traffic, and no one now will be rash enough to find fault with the automobile. We must grapple with the new problem presented to us in a suave way. The automobile has come to stay.

Crushed stone or properly prepared gravel, screened into different sizes, is a proper basis on which to build. This stone or gravel must be cemented together in some way to make it waterproof, solid as a rock, and free from dust. These three things must be combined in the proper construction of a street and treated with a preparation that will not be too slippery for horses. This can best be done with a treatment of asphaltic oil, mixed with coarse sand or fine screened gravel, mixed in the following proportions: One gallon of 60 or 65 per cent. asphaltic oil, using one gallon of oil to a cubic foot of sand, or in other words, about a barrel of oil to a good sized two-horse load of sand or gravel. When this is applied to the surface of the road, it should be spread evenly to a depth of about ¼ in. and raked with a fine rake. This preparation when used on a Tarvia road or on one of the bituminous treatments, provides good footing for horses and makes a fairly waterproof surface, preventing deterioration from the action of the weather. This preparation ought to be applied for about 1.5 cts. per sq. yd. and should last for about one season.

The methods and materials employed in dust prevention should be governed to a large extent by the amount and nature of traffic over the particular road treated.

The cost of the different classes of work can best be given in averages per square yard of surface treated.

In the city of Newton in the year 1912, something over 75 miles of roadway were treated with asphaltic and bituminous preparations. The cost of treatment with the various materials used was about as shown in the following table.

COST OF BITUMINOUS TREATMENT AT NEWTON, MASS.

Material.	Gallons.	Sq. Yds.	Cost, Averages.
Asphalt preparations, 65%	145,627	928,545	1¼ cts. penetration method 6 & 7 cts. mixing method.
Dustoline and Tasscoil...	32,255	99,000	1½ cts. each coat sprinkled
Standard Road Oil No. 3..	....	98,783	1 1/5 cts. each coat pressure
Tarvia X (del. hot on work)	47,897	43,869	21½-31-55 cts. (construction)
Tarvia B (used cold).....	18,018	108,000	1 4/5 cts. one coat
Tarine (surface on Tarvia B foundation)..........	8,012	42,190	1¾ cts. one coat
90% Road Binder	7,723	4,266	46 cts. construction
Ugite	8,000	....	General patching.

The principal agencies which tend to cause deterioration on Tarvia and oiled roads are frost, heavy rains and decaying organic matter on the surface, this last mentioned cause being, in my opinion, more destructive than any of the others. For this reason, a street after it is treated should be swept often enough to keep it clean and before any of these penetration treatments are applied, the roadway should, of course, be thoroughly cleaned by sweeping.

A properly treated road will resemble sheet asphalt, although much more resilient.

Some of the penetration treatments will give good results in a comparatively small city or town, but are not sufficiently durable for the heavier traffic.

The state of Massachusetts was among the first to use Tarvia and heavy asphaltic treatments on the surface of many of its state roads.

Before forming the subgrade to receive the concrete base, in constructing a new road, all present and prospective sewer, water, gas or subway connections should be made and extended under the curbs, and all old and new trenches should be thoroughly rolled with at least a 10-ton roller, and depressions should be filled and wetted and rolled until solid. Provisions should also be made for all surface drainage, which should be cared for through a system of pipes, connected into proper catch basins, with grates to receive the water at the sides of the road. All this should be carefully attended to before the road is considered ready for the surface.

A very good plan for a cobblestone paving for gutters is to lay the cobblestone on a bed of sand and have it thoroughly rammed; then mix up a grout of three parts of sand and one part cement and make a thin mortar, pour it over the surface of the stone and sweep it with a broom until it comes to an even, smooth finish on the surface. In most cases, it proves very satisfactory, as it will take care of the water very readily, be free from weeds and grass and make an ornamental finish for the side of the road.

I think that every municipality should be governed largely according to its own judgment in regard to how much money to spend, but should never think of being penurious in regard to street work. In many cities having a fine fire department, good schools, good water, good police protection, everything that goes to make a city attractive, you will often find the streets are kept in a wretched condition. This is both extravagant and unsatisfactory. If you can afford to build but one mile of street, build it well. The public at large

will be much better pleased with even one mile of good street for an object lesson and will be more ready to make an additional appropriation for other permanent improvements in the same line.

It is a wise economy to have plenty of steam road rollers, stone crushers and, in fact, all kinds of modern machinery, so that the work may be done as cheaply as possible.

In the past twenty years, I can see many places where permanent improvements have been of a durable nature and the work has been so satisfactory that other larger and more costly improvements have been entered into.

As I have already stated, where permanent improvements are to be made and the sewer, water and gas pipes are already laid in the streets, and in many cases the street railway tracks are already in place, there is no reason why this class of work should not be entered upon immediately. The public is always trying to obtain the best and the most that is possible for the dollar.

These facts are well worth considering and I am glad to see that the United States government and all the different states in the Union are being aroused to the fact that more money must be spent on highways; and it is only a question of a short time as to just what that construction will be. There was a time when the log house was the best that could be afforded; in many cities and towns at present the people are living in the old-fashioned log houses and are not looking for anything better in the line of improvement over their fathers or grandfathers. It is a well established fact that every home is made better by good roads, every farm is enhanced in value, in fact, every municipality is made richer by the amount of money that is spent on highway improvements.

I have never yet heard a complaint made that a city is extravagant in regard to its highways. In many cases, the amount of money appropriated for that purpose is what is left after the other appropriations have been made and if they come short, it is very often taken from the street department.

There are many places where the money spent has been squandered through lack of judgment. In many cities and towns, it is a common practice to shift the heads of the departments at each annual election. In my opinion, this is a grave mistake. If a man has done good work this year, he will be able to do better work next year, and so on. If an official can feel that his term of office is depending wholly on his methods and the quality of his work, he will cer-

tainly take more interest in it and will not feel as soon as he is elected that he is obliged to build his fences in place of building his streets.

CHAIRMAN TILLSON: The next formal discussion on this subject will be by Mr. J. S. Sturdevant, Division Engineer of the New York State Commission of Highways. Is Mr. Sturdevant present?

The next discussion was to have been by Mr. W. L. Hempelmann, Engineer of Bituminous Roadways of the Street Department of St. Louis, Mo. Mr. Hempelmann has written that he is unavoidably detained at the last moment and has not sent his paper. The next discussion then will be by Mr. C. F. Lawton, Superintendent of the Street Department of New Bedford, Mass. Mr. Lawton.

C. F. LAWTON (Superintendent, Street Department, New Bedford, Mass.): Mr. Chairman and Gentlemen: Excuse me if I read my remarks, because I am not sufficiently skilled as a speaker to be able to give them to you off-hand. But first, if I may be permitted, Mr. Chairman, I wish to divert a little from the paper that has just been read and speak on what I might call a matter of personal privilege.

The gentleman who spoke this afternoon from West Virginia has laid out the lines of thought of what I want to say, and I want simply to put a sort of finishing coat on that subject. I have noticed that some of the speakers at this convention have been inclined to speak slightingly of the civil engineer as a practical man. Now I happen to be by profession a civil engineer, and I am going to take exception to any slight put upon that profession. It is a mistake to assume that the engineer belongs to a class of impractical, unskilled, weak-muscled but strong-brained theorists, who can only design plans to be carried out by "practical" but less educated individuals.

Pardon me, please, for going into a little matter of personal reminiscence. My last previous visit to Philadelphia was in the great centennial year and at the great Centennial Exposition of 1876; in fact, I came twice to Philadelphia that year. Once I came as a student from the Massachusetts Institute of Technology in a corps of cadets, and camped on the University grounds in West Philadelphia; the second time was two months later, when I came as stroke in a whaleboat crew from the City of New Bedford, and rowed in a three-mile race on the Schuylkill River at the Centennial regatta. Gentlemen, every man who sat behind me in that boat and every man in the two other boats in that race were either men who had made voyages to sea on whale-

ships or were professional fishermen making their living on the water, and yet I think I am right in saying that the young student did just as good work with that 13-ft. ash oar as any of those men who had been brought up on the sea. And today I believe that I know better than the men that are working under me, be they foremen or laborers, how to repair a macadam road. But that is not the subject matter of the discussion. Now we will get right down to facts.

Somebody always has to be last, and I find that I am the last speaker listed on the program of this convention. You are probably getting tired of listening to this flow of talk, and I promise not to tire you by any long scientific discourse, but will only tell you in a few words what my own experience has been and what conclusions I have arrived at. Mayor Ashley of New Bedford, who is attending this convention, should perhaps have been the one to address you on this subject, as by his long years of service (he has just been elected to his seventeenth term as mayor) he has become a thorough master of all departments of municipal enterprise. I am now in my nineteenth year in charge of the highway department of New Bedford.

In a few words I will describe to you some of the features of our city. New Bedford is built on the west side of a salt water harbor and inflowing stream from the north. It is 11 miles long north and south, and 1½ miles wide. Cotton mills are strung along the water front for a distance of 5 miles. There is no industrial railroad to deliver material to the mills or take away the manufactured product, so that the teaming loads on the lower levels are extremely heavy. Loads of 10 to 15 tons on steel-tired wagons are common.

Outside of the strictly business sections of our city we have depended on macadam for a road surface. We now have nearly 100 miles of macadam streets. These are the streets on which our dust preventive methods must apply.

The material from which these roads are built is a soft granite, with a large percentage of feldspar, easily crushed and pulverized under traffic. The ground-up feldspar mixed with the fine particles of the quartz ingredient, gives a natural cementing and impervious quality to our road surface. On this account without the constant use of water or the application of some dust preventive the dust nuisance promised to become unbearable, but by careful methods of observation and experiment we believe we have become as nearly a dustless city as is to be found in New England.

Most advertised dust layers are either asphaltic or non-asphaltic oils—although there are hygrometric salts that

are utilized to some extent. There has been a good deal of discussion as to what particular article or compound constituted the best dust layer and we often find adjoining communities where road and traffic conditions are practically identical using entirely different materials and getting very variable results.

Heavy asphaltic oils are only dust preventives in so far as they furnish a road surface that in itself is practically dustless so far as its own composition is concerned, but there is nothing about such surface material that prevents dust from blowing when it is collected on the road from outside sources.

For country roads asphaltic surfacing is probably the best for the reason that the winds keep it swept clean. Automobile traffic is there more rapid and therefore more dust producing. Country roads are open to the winds and thereby are swept clean of what dust forms or what forms dust. The vegetable growth along sides of country roads gathers this dust and keeps it from blowing back upon the road so that no hand cleaning is needed.

In the cities, on the other hand, where road traffic is more dense and the accumulation of dirt much greater, asphaltic surfaces are not dustless unless constantly cleaned and frequently flushed. This is very expensive. If not thus taken care of the dust is blown back and forth across the street, over lawns and into houses or stores.

So if it is desired to avoid the large expense of hand cleaning and flushing of city streets some other form of dust preventive is required, some substance that will incorporate itself with the dust and either compact it into a dense smooth mass or render it so heavy that the wind will not hold it in suspension in the air. Of such character are some of the lighter oils and compounds, and for macadam or dirt roads they are preferable.

For several years we experimented with different grades of asphaltic oil and also many of the light oils, but for the last four years have used nothing but Dustoline, a compound or mixture of different refined non-asphaltic petroleum oils, which although a trifle higher in first cost than most of the light oils, more than makes up in its greater spreading and lasting character.

Including all expenses we have been able to oil our roads with Dustoline at an expense of 1 ct. per sq. yd. of actual area treated, for each application. In 1912, the last year for which we have full tabulated returns, one application was sufficient for 63 per cent. of the total mileage of roads treated, two applications for 29 per cent., three applications for 8

per cent. and four applications were made on less than ½ per cent. of the total area treated. Of course, it is unnecessary to say that a substance that thus holds the fine surface material in place, also acts effectively as a road preserver. This year the cost will be a little higher, because Dustoline, like most everything else, has advanced in price.

To make my opinion as emphatic as possible, I would say that no corporation, be it town, city, county, state or nation, that can afford to build and maintain macadam roads, can afford not to treat the surface of those roads either with some bituminous material or with some good dust preventive, which is as well a preservative.

CHAIRMAN TILLSON: That completes, gentlemen, the formal discussions. We will be glad now to hear from anyone in the convention who wishes to discuss the subject.

C. M. PINCKNEY (Engineer of Maintenance, Bureau of Highways, Borough of the Bronx, New York, N. Y.): I would like to ask what is the life of a tar treated road before it will have to be entirely resurfaced?

CHAIRMAN TILLSON: Perhaps the question is a little indefinite, but I will put it as the gentleman asks it; that is: What is the life of a tar treated road before it will have to be entirely resurfaced? Is there any gentleman who can answer that question within reasonable limits?

MR. PICKNEY: Assume it to be a perfectly water bound macadam and given a tar surface: How many years will it last considering that each year you might give it another treatment? How long would it be before the road would have to be completely renovated?

MR. CONNELL: I do not think that question can be answered. We have roads that have been treated in that way for years and are still in good condition.

MR. PINCKNEY: I asked this question for the reason that I think Mr. Connell knows the avenue to which I refer, Riverdale Avenue, in the city of New York. It is now five years old. It has had a surface treatment every year, and it is getting better each year, but there is some question as to whether or not there will be a disintegration in the lower portion of the road some day. I thought maybe somebody might have some information on the subject.

COL. WASHINGTON: I might add that in England they have some roads—tar roads—as much as 35 years old. They have some 31 years old, some 25 years old and some 23 years old, and many of them have had very little done to them; and some of them have had terrific traffic upon them. Some of them have had as much as 120 tons per

annum per yard in width, which is a very heavy traffic, equivalent to about 700 vehicles per yard in width. You can imagine what a terrific traffic that is.

I want to say this, that we have not yet found the ideal bituminous material for surface treatment of roads. I believe that it exists in some of the forms of asphalt—in some of the stages of the development of asphalt. Asphalt practically has three stages: It has the oil stage, it has the maltha stage and it has the harder stage. In one of these stages I believe we are going to find a satisfactory material when we can get a bituminous material that will be like a piece of chewing gum that will not harden and the oils of which will not volatilize and which won't dry out and won't harden more than a piece of chewing gum does when it is warm; and there is no reason why it should. When we get that, then we shall have a material that ought to last almost indefinitely, because it won't cut up or become brittle but will push to one side and the next vehicle that comes along will push it back. That is the thing we want to get—just the right masticity under a wide range of temperature. If we can get such a material, free from essential oils or with oils that are non-volatile, and keep it in that condition for years, there is no reason why the service of roads should not be of very long duration and very long value. Such material ought to save the wear of the under part of the road, and that carpet ought to take practically all the wear and act as a cushion.

MR. PINCKNEY: Mr. Chairman, the reason I brought this question up is that where you have a great mileage of macadam road, the financial undertaking to continue to build macadam roads and give them a surface treatment is quite a large item. I know that on requesting my appropriation this year, I was asked by the finance department when we would give up the macadam, and I said "Why should we give it up, when it's life is indefinite?" That statement is very much disputed and I am very glad to hear that nobody is certain how long it will last.

CHAIRMAN TILLSON: Is there any further discussion, gentlemen?

T. J. McGOVERN (Trenton, N. J.): I would like to ask if there is an engineer or chemist or contractor who knows anything better to resurface an old macadam road than a hot mixture of asphalt, sand and stone?

MR. CONNELL: What kind of a road? What is the character of the traffic?

MR. McGOVERN: It doesn't make a particle of difference

about the travel on it. You take the macadam roads throughout the country, and every different county road needs to be resurfaced under the automobile traffic—it draws the clay binder out. I wanted to find out if there is any man here who knows anything better than a hot mixture of asphalt, sand and stone. We have some roads—old worn-out macadam roads—in our county that have been resurfaced with these materials and that have lasted for five years. They look as well today as five years ago. I wanted to find out if there is any gentleman who has anything or knows of anything better?

MR. CONNELL: Well, I suppose we all have our little preferences, but to take any one type of bituminous surface treatment and ask if there is anything better than that I think can very easily be answered by saying: "Yes, there is something better than that." There is no one type of bituminous surface treatment, no one character of bituminous surface material, adapted to all classes and characters of roads. I think that can very easily be answered in that way. Under certain conditions, that is probably a good treatment. Under certain other conditions it would not be a good treatment, and under certain other conditions you can use a treatment that would cost probably one-third of that and answer the purpose.

MR. McGOVERN: What are the conditions where that treatment would not answer?

MR. CONNELL: Well, you want to first start by saying just what character of road you refer to for that kind of treatment.

MR. McGOVERN: I refer, as I said before, to an ordinary water bound macadam road, such as each county or state you go into has loads of.

MR. CONNELL: Well, I would say that on any ordinary water bound macadam road—a certain class of them, where you have good, hard trap rock and you don't have very extraordinarily heavy automobile travel—an application of tar or asphalt, cut back, used as a waterproofing coat, will give a treatment that, if applied each year or every two years, depending upon conditions, will last for an indefinite period, provided the road does not change its character as to traffic, etc.

MR. McGOVERN: I have been around to a good many conventions and visited a good many cities to find out if there is anything better. I, myself, have never seen anything better, but I thought possibly some of the other gentlemen from different parts of the country might have something. I have

seen those pavements mixed up and laid on top of cobbles and on top of old macadam and seen them there for ten years. I don't care what kind of traffic you run over them. We have streets in Trenton where that sort of treatment was used, and the heaviest automobile traffic—heavy trucks of 15 tons—go over it, and it is as perfect and level as this floor. And I thought I would just ask that question to see if there was some other gentleman here who could show me something better. If there is anything better, that is what we want to try to get in our state, but we have not yet found anything better. I am not interested in any asphalt or any pavement or any of these other arrangements. The asphalt is sold in the open market, you can buy it and buy the sand and buy stone and heat it up and mix it and put it on the road, and it is the best pavement I know of for that kind of road. Even our main street in Trenton is built that way and it has been there for seven years and looks good for seven more to me.

CHAIRMAN TILLSON: Is there any other discussion, gentlemen?

L. R. GRABILL (Superintendent of Suburban Roads, District of Columbia): If there is time for a little statement of experience, I think perhaps some of the members would be interested to know what some others are doing. I think perhaps we have had considerably too little of that experience in this meeting. At any rate, I have not heard as much as I would like to have heard; (applause) and while the experience may not be enlightening, I want to say what I have been doing in the way of dust prevention for the past year or two.

We have got down to a standard method, or as near a standard as we can get at the present time, as to time of application, materials to be applied, the means of application and amount applied on county roads with a fairly heavy travel in the neighborhood of a city. We have about 50 to 75 miles of such roads where we have to take care of the dust, and some of those have at times a very heavy automobile travel.

Our method is to start in the spring, about April 15, with a heavy asphaltic oil. We at one time had the oil applied by contract; but finding that contractors were not always available and that their prices were apt to include a profit which we did not care to pay, we procured our own plant and do the work entirely by hired labor. We employ two means of distribution; one is the Johnston sprayer, with which all of you are familiar, which is attached behind the

tank wagon and is pulled with a steam roller; and the other is the Monarch spraying wagon which distributes by means of a pump geared to the wheels. We find that we get over the ground quite as fast with the latter distributor as we do with the steam roller, but we have to apply a little more oil, so that it is not quite so economical.

Our roads have been treated for several years. We apply, at each application, about 1-5 gal. per sq. yd. of asphaltic oil or light coal tar heated to 100 to 120°. We use both oil and tar and they are both good. We buy our oil and our tar by contract, and sometimes we get one product and sometimes another, but we manage to keep a fairly uniform specification so that we get fairly uniform material.

The road roller which pulls the distributing wagon is supplied by wagons which bring the material from the cars as fast as the roller can handle it, and as fast as one wagon is empty, we drop that and put in another and go ahead with the roller. The roller will cover about 10,000 sq. yds. per day in an average day's work of 8 hours. If our oil costs 5 cts. per gal., which is about the average price, 1-5 gal. costs us one cent for oil. We cover that immediately with sand. We seldom block the width of the road, because we cannot do it; we haven't any other place to put the travel; so that we oil one-half of the width of the road at a time, cover it with sand immediately and throw that open to travel while we are covering the other half.

Before the application, we first sweep the road thoroughly with horse brooms, and if there are any rough spots or small dirty spots left, they are cleaned up with hand brooms so that the road is clean.

In covering with the sand, we use a coarse torpedo sand, as coarse as we can get, which costs us about $2.00 per cu. yd. at the job, and we use 1 cu. yd. to 200 sq. yds. of the surface to which it is applied. That makes the sand cost us 1 ct. per sq. yd. The roller and the outfit which applies the oil cost us about $35 a day and we apply 10,000 sq. yds., which gives a cost for labor for application of oil and cover, usually, of somewhat less than ½ ct., so that the whole cost of one application is about 2½ cts. per sq. yd.

We get over our territory as fast as we can with that plant, and the portion which we cannot cover with the steam plant, we cover with the horse plant.

We find that we have to make two applications per season to keep the roads in good condition. In a few places more are required, and there are very few places that require less, so that we have a cost for the season of about 5 cts.

per sq. yd. That applies either with asphaltic oil or with the light tars, such as Tarvia B.

Where we continue the treatment of the same road with the same class of material for several years, we find that we can use as low as about 0.1 gal. per sq. yd. for a moderately traveled road. That is probably the lowest cost we have yet reached for moderate travel; for, if oil or tar costs 5 or 6 cts. per gal., and you use only 0.1 gal. per sq. yd., you are paying very little for your material. The cost of labor for such applications is about the same as where more is applied.

We find, as a rule, that the Tarvia B treatment requires, on the moderately traveled roads, only one application per year where possibly the oil treatment would require two. (Applause.)

EZRA STOLTZFUS (Gap, Pa.): As a member, I would like the privilege of the floor for a few minutes to address the convention in regard to the matter from the farmer's standpoint.

Being a farmer, I can only say that I am and always was a good roads advocate. The utter impossibility of building the 2,250,000 miles of roads of concrete or bituminous macadam is evident, and even if it were a possibility it wouldn't be prudent to build them all that way. The road that first appeals to man is the one that he always uses when he goes out. My natural inclination is toward lumbering. I own a steam portable sawmill and numerous tracts of timber and wood land in Chester County, Pa. I also own a feed and grist mill and a farm. For personal reasons, I temporarily closed down my lumbering business and took charge of the feed and grist mill. Later I bought a farm and moved on it and took up farm work, partly for the sake of the ones for whose welfare I am responsible to a certain extent, and possibly partly from selfishness, for I always looked upon the farmer as being in a position to be the most independent man on earth. There's a natural reason, for the one who is next to Nature in producing the essentials of life has a perfect right to eat at the first table of the land.

The great national question today is to keep the boys and girls on the farm. Do you think I had any desire to give up country life and move to the city, to make my fortune? The busy and active city life appealed greatly to me, but there was something, somehow, which I could not decide to give up on the farm. It has been said: Improve the roads and thereby keep the boys and girls on the farm. That's right, in a sense, but the roads to improve for that purpose are the ones

that connect the farming communities. These roads are the ones which will always be earth roads.

A successful physician will carefully study the disease before he applies the remedy. In the bad road disease, or epidemic, which we have, the natural cause is the water. I am an earth road advocate; I may even be called a fanatic. It always has been the case that people who had advanced ideas were considered "off."

I see a great possibility in road building by using a filler and binder on earth roads, thereby making them waterproof and frost proof. Let us get the fact impressed on our minds that water is the great destructive element of our roads; then let us, as engineers and scientists, take up the question of how we can put that earth into such condition that it will not absorb the water that comes to it. We know that by some natural cause, sometime, what has been at one time soft or earthy material has formed into stone. My thought is this: We farmers know that if we plow or work the soil while it is wet it will have the natural effect of closing up the pores of the soil. If we know this, why do we not get the farmer interested to bring about this result on the roads? I sincerely believe it can be brought about if the subject is given proper thought and intelligent energy. Is it not a fact that to keep out of the mud we must use stone? Is it not reasonable to think that by studying the laws of Nature and by working in harmony with Nature we can bring about undreamed results? Our friend and neighbor from the South has told us that if they could always do the work where the natural conditions were right, they could build a road that was not too expensive to be built everywhere and which would bring about the desired result.

MR. McGOVERN: I would like to ask one more question, and that is in reference to the cost. I want to see if our city is getting the best and a cheap pavement. We excavate a foot of dirt and lay 4 ins. of Portland cement concrete, 1:3:5, 2 ins. of asphalt, sand and stone pavement and guarantee it for 5 years, for $1.27 per sq. yd. I would like to know if there is any delegate here who does any cheaper work than that in his town or state.

COL. WASHINGTON:What thickness of base?

MR. McGOVERN: Four inches of concrete base; 4 ins. of concrete, 2 ins. of bituminous wearing surface, asphalt, sand and stone—with 11 per cent. of bitumen. And it is guaranteed for 5 years.

MR. SHIRLEY: The cost of paving depends a great deal on the availability of stone and material. I have laid a similar

character of pavement at $1.20 on one contract—4-in. concrete base, 2-in. top (Topeka specification)—and on another contract at $1.27 per sq. yd. The average haul from the plant to the second contract was about 3½ miles.

MR. McGOVERN: Was excavation included in that?

MR. SHIRLEY: Everything was included in that.

CHAIRMAN TILLSON: What was the thickness of the concrete?

MR. SHIRLEY: Four-inch concrete base, 2-in. top, 1:3:6 concrete base, and the top was Topeka specification top, $1.20 per sq. yd., road complete, for the first contract; and $1.27 for the second, laid on an old stone roadbed where we had to only scarify and shape, and had very little excavation.

MR. McGOVERN: Was there a 5-year guarantee?

MR. SHIRLEY: No guarantee whatever.

MR. McGOVERN: Oh! that is different. We laid it for from 60 to 80 cts. without any guarantee.

MR. CONNELL: I am going to ask if Mr. Pinckney, of the Bronx, could give us a few figures on his cost on bituminous surface treatment? I know they have an organization there that is well able to handle the work, and costs are about down to a minimum. I would like him to describe the character or the kind of treatment.

MR. PINCKNEY: We have three classes of surface treated roads. We have one main show road which is called the Grand Boulevard and Concourse, about two and a half miles long, which has two roadways 34 ft. wide. We have maintained the Concourse by the patrol system. This year we found that we had to give a paint coat to about one-third of the total area, for the reason that the patching was heavy and made it slightly rough. We simply leveled it up with a paint coat. Including the paint coat and patching, it cost us a slight fraction less than 3 cts. per sq. yd. per year to maintain, and I feel confident when I say I believe it is one of the best maintained parkways in this country.

On our tar treated roads, where we use Tarvia B treatment, we figure on giving each road one treatment a year; it costs us about 3½ to 4 cts. per sq. yd. including tar and torpedo sand. Our poor macadam and earth roads we give a treatment of asphalt road oil without any covering; that costs us a little less than 3 cts. per sq. yd. Our costs have been reduced materially by laying out, each spring, our scheme of work and regulating our deliveries and shortening our hauls by having storage. I believe the figures for 1912 for an asphalt oil were around 4½ to 5 cts., and we have reduced that to 3 cts. On the tar treated roads, we

reduced it from 6 to 4 cts., and I believe that with better deliveries next year we will reduce it materially lower than that.

COL. WASHINGTON: Are your roads gaining anything from accretion?

MR. PINCKNEY: No, we find that we give them about ⅛ gal. a year, and we find that when we come to treat them each year the stone is just commencing to show through. If it is not commencing to show through, we leave the treatment until later on in the season when it is commencing to show, in order to prevent a pad.

CHAIRMAN TILLSON: Is there any further discussion?

COL. WASHINGTON: Let's hear from Mr. Parker, he is an old war horse.

CHAIRMAN TILLSON: Mr. Parker knows how to speak for himself; we will be glad to hear from him.

HAROLD PARKER: Well, gentlemen, I should like to say that I think you have had about all the wisdom that you can well digest this afternoon, already, and I think that it is a great deal wiser for us now to close with what you have heard. If I should go into the question of the cost of maintenance, I know every one of you, including Mr. Flanigan, would differ from me. In Baltimore they have one view and I know perfectly well that my ideas of cost do not accord with the ideas of the people in Maryland, because my business is that of a contractor, and in Maryland they practically always underbid me; they think the work can be done for a less sum than I think it can be done. So probably we would not agree. I think it is better, therefore, for you to take up the question of closing this meeting while we are all in harmony. (Applause and laughter.)

MR. McGOVERN: I would simply like to say that in the country districts where we put 2 ins. of wearing surface over the old macadam pavement and guarantee it for 5 years, we do it for 53 cts. per sq. yd. I would like to know if there is any cheaper work than that around anywhere? We put in enough sand to fill the voids of the stone and enough of bitumen to thoroughly coat them both—¾-in. stone. We do not do anything with the old surface, just go along and put this over the top of it, 2 ins. thick. If there is a hole in it, we don't even bother cleaning it out, and we have got a road there that has been down 5 years and is as level as this floor.

DELEGATE: What is the length of the average haul?

MR. McGOVERN: Three miles.

CHAIRMAN TILLSON: Is there any further discussion, gentlemen? If not, we will proceed with the next order of

business, reports by committees. Are there any committees to report?

[Wm. H. Kershaw read the following communication from Second Vice President W. A. McLean, a member of the Committee on Standards.]

Philadelphia, Pa., Dec. 12, 1913.

SAMUEL HILL, Esq.,
President, A. R. B. A.

Sir:—

At the request of the Chairman, Mr. N. P. Lewis, who is unavoidably absent, I beg to advise that the Committee on Standards appointed by you has had one meeting; that preliminary organization has been effected; that we are of the opinion that a useful service can be performed by such a committee; and that, should it be the wish of the Association to continue the committee, a progress report will be made at the annual meeting.

Yours respectfully,
W. A. McLEAN,
Member of the Committee.

COL. WASHINGTON: I move that we accept the report.

MAJ. CROSBY: I wanted to make a motion that the report of the committee be accepted and that the action of the President in appointing the committee be approved and the committee continued.

[The motion as made by Maj. Crosby was seconded, put and carried.]

CHAIRMAN TILLSON: Are there any other committees to report? If not, the next thing in order is the selection of the Nominating Committee, which is made by the meeting as a whole.

W. D. UHLER (Assistant Engineer, Bureau of Highways and Street Cleaning, Philadelphia, Pa.): I move that the following Committee on Nominations be appointed: Nelson P. Lewis, Chief Engineer of the Board of Estimate and Apportionment, New York, N. Y.; John A. Gaffey, Medford, Mass.; F. L. Ford, City Engineer, New Haven, Conn.; J. A. Johnston, Division Engineer, Massachusetts Highway Commission; Geo. W. Cooley, State Engineer of Minnesota; Joseph W. Hunter, Deputy State Highway Commissioner of Pennsylvania, and Wm. H. Connell, Chief of the Bureau of Highways and Street Cleaning of Philadelphia, Pa.

[Mr. Uhler's motion was seconded and carried, the Secretary being directed to cast a unanimous vote for the committee as named.]

CHAIRMAN TILLSON: Is there any other business? If not, the Chair will entertain a motion to adjourn.

[Adjournment.]

The Association Banquet

The last event of the Fourth American Good Roads Congress was the annual banquet of the American Road Builders' Association, held on the evening of the fourth day of the meeting, Friday, Dec. 12. The banquet was held in the Red Room of the Bellevue-Stratford Hotel and was attended by about seventy-five A. R. B. A. members, delegates and guests.

Several speeches were made after dinner, President Samuel Hill of the A. R. B. A. acting as toastmaster. Those who spoke were: President Hill; J. P. Connelly, Chairman of the Finance Committee of the City of Philadelphia; George W. Tillson, Consulting Engineer to the President of the Borough of Brooklyn, New York, N. Y., and Third Vice President of the A. R. B. A.; Alexander Lawrence, Jr., Chairman of the Finance Committee of the Congress; James H. MacDonald, former State Highway Commissioner of Connecticut and Past President of the A. R. B. A.; H. B. Taylor, President of the Philadelphia Society of Engineers; Major W. W. Crosby, Chief Engineer of the Maryland Geological and Economic Survey, and Treasurer of the A. R. B. A., and William H. Connell, Chief of the Bureau of Highways and Street Cleaning of Philadelphia.

The menu follows:

CAPE MAY SALTS

CREAM OF CELERY, AUX CROUTONS

Salted Almonds Relishes Pecan Nuts

Celery Olives

KINGFISH, MEUNIERE

New Potatoes, Buttered

PATTIE OF SWEETBREAD

ROAST SQUAB

Sweet Potatoes, Candied

SHERBET

CHIFFONADE SALAD

Cheese Prints Toasted Crackers

FANCY ICES IN FORMS

Assorted Cakes

COFFEE

Cigars Cigarettes

LIST OF EXHIBITORS

Commercial

Acme Road Machinery Co., Frankfort, N. Y.
American Bar Lock Co., Philadelphia, Pa.
American Rolling Mill Co., The, Middletown, O.
Amies Road Company, Easton, Pa.
Art Stone Co., Waynesboro, Pa.
Association of American Portland Cement Manufacturers, Philadelphia, Pa.
Autocar Company, The, Ardmore, Pa.

Bain Wagon Company, The, Kenosha, Wis.
Baker & Co., R. D., Detroit, Mich.
Barber Asphalt Paving Co., The, Philadelphia, Pa.
Barrett Manufacturing Company, New York, N. Y.
Bausch & Lomb Optical Co., Rochester, N. Y.
"Better Roads," Jamestown, O.
Blanchard & Hubbard, New York, N. Y.
Bucyrus Company, South Milwaukee, Wis.
Buff & Buff Mfg. Co., New York, N. Y.
Buffalo Pitts Company, Buffalo, N. Y.
Buhler Company, Edward E., New York, N. Y.

Carey Co., The Philip, Lockland, Cincinnati, O.
Case Threshing Machine Co., J. I., Racine, Wis.
Champion Wagon Company, The, Owego, N. Y.
Clip Bar Mfg. Co., Philadelphia, Pa.
Columbia Wagon Co., Columbia, Pa.
"Concrete Cement Age," Detroit, Mich.
Concrete Form & Engine Co., Detroit, Mich.

Dolarway Paving Company, New York, N. Y.
Dunn Wire-Cut-Lug Brick Co., The, Conneaut, O.
Dustoline for Roads Company, The, Summit, N. J.

Eagle Wagon Works, The, Auburn, N. Y.
"Engineering News," New York, N. Y.
"Engineering Record," New York, N. Y.

Farquhar Co., Ltd., A. B., York, Pa.
Frick Co., Waynesboro, Pa.

Galion Iron Works & Mfg. Co., The, Galion, O.
"Good Roads," New York, N. Y.
Good Roads Machinery Co., Inc., The, Kennett Square, Pa.
Gurley, W. & L. E., Troy, N. Y.

Hartranft Cement Co., Inc., Wm. G., Philadelphia, Pa.
Hassam Paving Company, Worcester, Mass.
Headley Good Roads Company, Philadelphia, Pa.
Huber Mfg. Co., The, Marion, O.
Hunt & Co., Robert W., Chicago, Ill.
Hvass & Co., Chas., New York, N. Y.

Ingersoll-Rand Company, Philadelphia, Pa.
Ingram-Richardson Mfg. Co., Beaver Falls, Pa.
Iroquois Works, The Barber Asphalt Paving Co., Buffalo, N. Y.

Jennison-Wright Co., The, Toledo, O.

Kent Machine Co., Kent, O.
Kentucky Wagon Mfg. Co., Louisville, Ky.
Keuffel & Esser Co., Hoboken, N. J.
Knickerbocker Company, The, Jackson, Mich.
Knox Automobile Company, Springfield, Mass.
Koehring Machine Company, Milwaukee, Wis.

Lacy & Hursh, Philadelphia, Pa.
Lansing-Company, Lansing, Mich.
Link-Belt Company, Philadelphia, Pa.
Locomobile Company of America, The, Philadelphia, Pa.

McAvoy Vitrified Brick Company, The, Philadelphia, Pa.
Marion Steam Shovel Co., The, Marion, O.
Merchant & Evans Co., Philadelphia, Pa.
Milburn Co., The Alexander, Baltimore, Md.
Mulholland, John H., Philadelphia, Pa.
"Municipal Journal," New York, N. Y.

National Corrugated Culvert Co., West Berkeley, Cal.
National Paving Brick Manufacturers' Association, Cleveland, O.

Oliver Chilled Plow Works, South Bend, Ind.

Packard Motor Car Co. of Philadelphia, Philadelphia, Pa.
Pickett Co. Inc., H. W., Philadelphia, Pa.
Pittsburgh Testing Laboratory, Pittsburgh, Pa.

Rapid Mixer Company, The, Grand Rapids, Mich.
Robeson Process Company, Pennington, N. J.
Roche, T. M., Chicago, Ill.
Rocmac Limited, Inc., Philadelphia, Pa.

Shannon & Co., J. Jacob, Philadelphia, Pa.
Shannon Self Locking Metal Culvert Co., Cincinnati, O.
Silican Products Co., Lancaster, Pa.

Standard Oil Company of New York, New York, N. Y.
Steel Protected Concrete Company, Philadelphia, Pa.

Tarrant Manufacturing Company, Saratoga Springs, N. Y.
Texas Company, The, New York, N. Y.
Thew Automatic Shovel Co., The, Lorain, O.
Troy Wagon Works Co., The, Troy, O.
Trussed Concrete Steel Company, Detroit, Mich.

United Gas Improvement Co., The, Philadelphia, Pa.
Union Iron Works, Hoboken, N. J.
United States Asphalt Refining Co., The, New York, N. Y.
United States Wood Preserving Co., New York, N. Y.
Universal Portland Cement Co., Chicago, Ill.
Universal Road Machinery Co., Kingston, N. Y.

Van Duzen, Roys & Co., Columbus, O.

Waring-Underwood Company, Philadelphia, Pa.
Warner-Quinlan Asphalt Company, New York, N. Y.
Warren Brothers Company, Boston, Mass.
Warren-Knight Co., Philadelphia, Pa.
Waterloo Cement Machinery Corporation, Waterloo, Ia.
Watson Wagon Company, Canastota, N. Y.
Wheeling Corrugating Company, Wheeling, W. Va.
Wheeling Mold & Foundry Co., Wheeling, W. Va.
Wiard Plow Co., Batavia, N. Y.

Yellow Pine Manufacturers' Association, St. Louis, Mo.

National, State, Municipal and Educational

United States Office of Public Roads.
State of Colorado.
State of Kentucky.
State of Massachusetts.
State of New Jersey.
State of New York.
State of North Carolina.
State of Rhode Island.
State of Washington.
Territory of Alaska.
Province of Ontario, Canada.
City of New York.
City of Philadelphia.
Columbia University.
University of Pennsylvania.

ANNUAL MEETING

The annual meeting, as provided for in Chapter I, Section 1, of the By-Laws, was held at the Hotel Astor, New York, N. Y., February 6, 1914.

Executive officers and six directors were duly elected. The complete list of officers and directors for 1914 will be found on pages 302-303.

The reports of the Executive Committee, Secretary and Treasurer were read and duly accepted. These reports are given on this and following pages.

The report of the Committee on Amalgamation with other associations was read by Geo. W. Tillson, chairman of the committee. It was moved, seconded and carried that the report be accepted and placed on file, and that the thanks of the Association be extended to the members of the committee, Geo. W. Tillson, E. L. Powers and R. A. Meeker, and the committee discharged.

The following motion was made, seconded and carried:

RESOLVED, That it is the sense of this meeting that it would be desirable to hold a joint convention with the American Highway Association, and that this meeting instruct the Board of Directors to consider this question, and furthermore, give them full powers to decide whether or not such a joint convention shall be held this year.

Annual Report of the Executive Committee of the American Road Builders' Association

New York, N. Y., February 6, 1914.

To the Board of Directors, American Road Builders' Association.

Gentlemen:

As provided by Chapter 111, Section 8, of the By-Laws of the Association, the Executive Committee begs to submit herewith its annual report as follows:

Since the last annual meeting, the membership of the Association has been increased by the election of 266 members. Nine members have resigned, leaving a total membership of 648 to date.

The reports of the Treasurer and the Secretary, which are herewith submitted, show that on December 31, 1913, there was a balance on hand of $3,952.99, that there were bills receivable amounting to $1,852.44, and accounts payable amounting to $3,103.62, leaving a net surplus of $2,701.81. This sum, it is believed, will be sufficient to meet all the re-

quirements for the printing of the Proceedings of the convention, and such other incidental expenses as may be incurred up to the time of the next convention.

The Tenth Annual Convention was held in Philadelphia, December 9, 10, 11 and 12, 1913. The meeting may be considered as the most successful convention and congress ever held under the auspices of the Association. The registered attendance was 3,171, and to this should be added a large number who passed in and out the doors of the convention without registration, making, it is believed, an attendance of upwards of four thousand. This meeting, it is felt, was the largest gathering of the kind ever held in the world.

The exhibition held in connection with the convention was participated in by a much larger number of exhibitors than at any previous convention. There was a total of one hundred (100) commercial exhibits, nine (9) state and territory exhibits, two (2) city exhibits and two (2) colleges; also exhibits from the United States Department of Agriculture and the Province of Ontario, Canada.

The total amount of sales of space, for electric current, etc., amounted to $8,854.56. The expenses, including traveling expenses of the Convention Committee, were $7,862.32

Your Committee believes that while the active membership of the Association has grown, and is growing, very satisfactorily, there should be a greater effort put forth to securing members. To this end it is recommended that a Membership Committee be appointed for the purpose of taking up the question systematically, and devising ways and means for securing a much greater number of active members. The members of your Committee have discussed this subject at various times, including the plan suggested of establishing branch organizations in the several states. The matter presents a number of problems, not easy of solution, but the idea of a road builders' association is surely becoming more popular with the engineers, contractors and road and street officials, and it is believed that by getting the matter fairly before the men whose memberships are desired, it should not be a difficult matter to greatly appreciate the membership during the present year.

During the year, at the instance of your Committee, the President has appointed a Committee on Standards, as follows: Nelson P. Lewis, George W. Tillson, A. W. Dean, S. D. Foster, R. J. Potts, A. B. Fletcher, C. A. Kenyon, W. A. McLean, Jos. H. Pratt, Frank F. Rogers and Henry L. Bowlby.

On motion made and carried at the Philadelphia meeting,

a Committee on Legislation was appointed by President Hill, consisting of the following names: W. A. McLean, E. L. Powers, Jos. H. Pratt, A. J. Johnson and A. R. Hirst.

In accordance with the resolution adopted at a meeting of the Board of Directors, May 29, 1913, an emblem of the Association was decided upon, and a number of pins have been supplied to members. Respectfully submitted,

Executive Committee,
(Signed) Geo. W. Tillson, Chairman.
E. L. Powers,
R. A. Meeker.

Secretary's Report

December 31, 1913.

To the Board of Directors,
American Road Builders' Association.

Dears Sirs:—

I have the honor to present a report, showing receipts and disbursements of the Association by the Secretary for the year from December 31, 1912, to December 31, 1913, as required by the By-Laws.

I also present herewith a general balance sheet, showing the assets and liabilities of the Association.

1913	RECEIPTS		1913	DISBURSEMENTS	
Jan. 1,	Cash on hand	$376.56		Monies received from current sources and sent to Treasurer Crosby January 1, 1913, to December 31, 1913	$7,635.08
	Exhibition Space	8,195.00	Dec. 31,	Cash on hand.	2,386.22
	Membership Dues	912.90			
	Sundries	536.84			
		$10,021.30			$10,021.30

GENERAL BALANCE SHEET.

1913	ASSETS		1913	LIABILITIES	
Dec. 31,	Cash on hand, Treasurer	$1,566.77	Dec. 31,	Accounts payable	$3,103.62
	Cash on hand, Secretary	2,386.22		Surplus	2,701.81
	Due from exhibitors	1,079.00			
	Due for electric service.	513.52			
	Due for sundries	76.42			
	Membership dues for 1913 unpaid (billed)	183.50			
		$5,805.43			$5,805.43

(signed) E. L. POWERS,
Secretary.

Treasurer's Report

December 31, 1913.

To the American Road Builders' Association,
New York, N. Y.

Gentlemen:—

As required by Section 6, Chapter III, of the By-Laws, I herewith submit my report as Treasurer for the year.

Balance on hand January 1st, 1913:		
In Corn Exchange Bank, New York	$927.95	
In Essex National Bank, Montclair, N. J.	232.43	
		$1,160.38
Received from the Secretary January 1st, 1913, to December 31st, 1913	$7,635.08	
Received direct for dues, 1913	4.00	
Received from the Essex National Bank interest on account for year ending December 31st, 1913	24.21	
		7,663.29
Total		$8,823.67
Paid Audited Vouchers for current business, January 1st to December 31st, 1913		7,256.90
		$1,566.77
In Corn Exchange Bank, New York	$155.65	
In Essex National Bank, Montclair, N. J.	1,409.74	
In hands of Treasurer	1.38	
		$1,566.77

Respectfully submitted,
(signed) W. W. CROSBY,
Treasurer, A. R. B. A.

AMERICAN ROAD BUILDERS' ASSOCIATION

Constitution

ARTICLE I.

Name.

This Association shall be known as the American Road Builders' Association.

ARTICLE II.

Seal.

The official seal shall be circular in form and bear the words "American Road Builders' Association Corporate Seal 1910."

ARTICLE III.

Location.

The headquarters of the Association shall be located in the City of New York, New York.

ARTICLE IV.

Objects.

The objects for which this Association is organized are to acquire and disseminate information concerning highway construction and maintenance in the States and Cities of the Union and in the Provinces and Cities of Canada; to stimulate interest in the subject and to promote educational, legislative and other measures tending to their accomplishment.

ARTICLE V.

Membership.

Section 1. The Association shall have five (5) classes of members, viz., active, associate, honorary, contributing and life members.

Sec. 2. Active members shall be persons who are actively engaged in laying out or supervising work of construction and maintenance of highways and streets and those interested in highway development. Active members shall be elected in accordance with the by-laws adopted by the Association.

Sec. 3. Associate members shall consist of societies or other organizations interested in the objects of the Association.

Sec. 4. Honorary members shall be those who have performed distinguished service in the cause of highway extension and improvement. They shall be nominated by the Board of Directors and elected by the Association.

Sec. 5. Contributing members shall be commercial bodies who contribute one hundred dollars ($100.00) per year.

Sec. 6. Life members shall consist of active or associate members making a payment of five hundred dollars ($500.00) upon their election to membership.

Sec. 7. Only active members shall vote or hold office.

ARTICLE VI.

Officers.

Section 1. The officers of this Association shall be selected from its active membership and shall consist of a president, three vice-presidents, eighteen directors, a secretary and a treasurer, who shall constitute a board of directors, from which shall be elected an executive committee of three, one of whom shall be the secretary of the Association.

Sec. 2. The President, Vice-Presidents, Secretary and Treasurer shall be elected for one year. Six Directors shall be elected each year to serve for three years, except that at the first annual meeting after the adoption of this Constitution six directors shall be elected for three years, six for two years and six for one year.

ARTICLE VII.

Sections.

For the purpose of carrying on the work of the Association, sections may be established in as many of the States of the Union and Provinces of Canada as may seem desirable. Each section shall be presided over by an active member of the Association.

ARTICLE VIII.

By-Laws.

By-Laws for governing this Association shall be made by the Board of Directors, subject to the approval of the active membership of this Association.

ARTICLE IX.

Amendments.

Section 1. An amendment to this constitution shall first be proposed by at least five (5) active members and submitted to the Board of Directors, a majority of which shall approve before the amendment, with letter ballot, is sent to the active members of the Association.

Sec. 2. Amendments may be adopted only at any regular or special meeting of the Association, provided that a notice of such meeting, including the proposed amendment and a letter ballot shall have been sent to each member of the Association thirty (30) days before said meeting. An affirmative vote of three-fourths of all ballots cast shall be necessary for the adoption of any amendment.

By-Laws

CHAPTER I.

Meetings.

Section 1. The annual meeting of the Association for the election of officers and the transaction of business shall be held on the first Friday in February of each year. Conventions of the Association for the reading and discussion of papers, social intercourse and reports of committees, shall be held at such times and places as the Executive Committee may determine, subject to the approval of the Board of Directors.

Sec. 2. Special meetings may be called by the Board of Directors or may be called on the request of thirty (30) active members, which request shall state the object of the meeting. Notices of such meeting shall be sent out ten (10) days in advance and no other business be considered than that stated in the notice.

CHAPTER II.

Election of officers.

Election of officers shall be as follows: At the Fall convention a nominating committee of seven (7), not more than two (2) of whom shall be residents of a single state, shall be chosen by the Association, and this committee shall submit to the Secretary within three (3) weeks the names of not less than one (1) or more than three (3) candidates for each office to be filled. Letter ballots shall be then sent by the Secretary to each active member at least thirty (30) days before the date of the annual meeting stating the hour at which the polls will close. The ballots shall be returned to the Secretary enclosed in two envelopes, the inner one to be blank and

the outer one endorsed with the signature of the active member voting. Two tellers shall be appointed by the President, and the result of the ballots shall be announced at the annual meeting. The candidate having the largest number of legal votes by letter ballot shall be declared elected.

In case of failure to elect an officer on account of a tie vote, the meeting shall proceed to ballot for such office, the choice of candidates being limited to the persons so tied. Vacancies occurring in any office may be filled by the Board of Directors at any meeting provided notice of such vacancy shall be sent to each member of the Board at least ten (10) days before such meeting. A majority, of the votes cast shall be necessary to elect.

CHAPTER III.

Duties of Officers.

Section 1. The President shall be the presiding officer at all meetings of the Association, and shall perform the duties usually devolving upon such officer. The President shall be ineligible for re-election for one year.

Sec. 2. The First Vice-President shall, in the absence of the President, preside at the meetings of the Association, and in the disability of the President shall perform the duties of the President.

Sec. 3. The Second Vice-President shall, in the absence of the President and First Vice-President, preside at the meetings of the Association and perform the duties of the President.

Sec. 4. The Third Vice-President shall, in the absence of the President and First and Second Vice-Presidents, preside at the meetings of the Association and perform the duties of the President.

Sec. 5. The Secretary shall keep the records and complete reports of the proceedings of the Association, and shall conduct all necessary correspondence connected with the affairs of the Association. He shall notify all members who are in arrears in dues and shall attend to such other affairs of the Association as fall particularly to his office, and such other duties as may be placed upon him by the Board of Directors. At the annual meeting of the Association, the Secretary shall make a written report of the work, and shall also make such special reports to the Board of Directors as it may require from time to time. He shall draw all vouchers on the Treasurer for the payment of money.

Sec. 6. The Treasurer shall hold in safe keeping, in a bank designated by the Board of Directors, all the moneys paid to the Association, and shall expend same only in the payment of vouchers duly drawn by the Secretary and approved by the President or such general officer as may be designated by him. He shall keep an accurate account of receipts and expenditures, and shall make a written annual report at the annual meeting of the Association. He shall submit his annual report to the Board of Directors on or before the second Friday in January. If required by the Board of Directors, the Treasurer shall file a bond in such amount as may be required.

Sec. 7. The Board of Directors shall have the general management of the affairs of the Association as trustees, in conformity to the laws under which the Association is organized and the provisions of the constitution. It shall direct the

investment and care of the funds of the Association, make appropriations for specific purposes and take measures to advance the interests of the Association. The Board of Directors shall make an annual report at the annual meeting, and shall transmit the report of the Secretary and Treasurer and other officers and committees. These reports shall be printed and sent to the members of the Association at least ten (10) days before the annual meeting.

Sec. 8. The Executive Committee shall exercise a general supervision over the affairs of the Association. It shall report annually to the Board of Directors the condition of the Association and recommend any measures which seem advisable to adopt for the best interests of the Association. The Executive Committee shall also have such other powers as may be given it from time to time by the Board of Directors.

CHAPTER IV.

Election of Members.

Applications for membership shall be made on forms provided by the Association and endorsed by one active member and shall be acted upon by the Executitve Committee. Upon the approval of the Executive Committee and payment of the required dues, the applicant shall become a member.

CHAPTER V.

Dues.

Section 1. The annual dues for active members of the Association shall be two dollars ($2.00), payable in advance.

Sec. 2. The annual dues for associate members shall be ten dollars ($10.00), payable in advance.

Sec. 3. Annual dues for contributing members shall be one hundred dollars ($100.00), payable in advance.

Sec. 4. Dues shall be due and payable January 1st of each year.

Sec. 5. Neglect to pay dues for six months after notification by the Secretary shall be sufficient cause for the removal of the member's name from the roll by the Executive Committee without further notice.

CHAPTER VI.

Quorum.

Section 1. Five directors shall constitute a quorum at any regular or special meeting of the Board of Directors.

Sec. 2. Fifteen active members shall constitute a quorum at any regular or special meeting of the Association.

CHAPTER VII.

Congresses.

If it shall be deemed expedient to hold a congress of road builders in connection with any of its conventions, no action that such congress may take shall be binding upon the American Road Builders' Association, except the Association shall vote to be so bound.

CHAPTER VIII.

Amendments to By-Laws.

These by-laws may be amended, revised or changed by the Board of Directors, subject to the approval of the voting membership at its next regular meeting. Emergency changes may be made temporarily effective by the consent of the majority of all the members of the Board, but such changes shall only be effective until the next meeting of the Association, when it shall be voted upon by the Association.

OFFICERS, 1914

President
W. A. McLEAN, M. Can. Soc. C. E.
Chief Engineer of Highways and Commissioner, Ontario Public Roads and Highways Commission

First Vice-President
GEORGE W. TILLSON, M. Am. Soc. C. E.
Consulting Engineer, Borough of Brooklyn

Second Vice-President
A. W. DEAN, M. Am. Soc. C. E.
Chief Engineer, Massachusetts Highway Commission

Third Vice-President
AUSTIN B. FLETCHER, M. Am. Soc. C. E.
State Highway Engineer of California

Secretary
E. L. POWERS
Editor "Good Roads"

Treasurer
W. W. CROSBY, M. Am. Soc. C. E.
Consulting Engineer

DIRECTORS

TERM EXPIRES 1917

ARTHUR H. BLANCHARD, M. Am. Soc. C. E.
Professor of Highway Engineering, Columbia University

FRED E. ELLIS
Manager, Essex Trap Rock & Construction Company

R. H. GILLESPIE, M. Am. Soc. C. E.
Chief Engineer of Sewers and Highways, Borough of the Bronx

SAMUEL HILL
President, Washington State Good Roads Association

HAROLD PARKER, M. Am. Soc. C. E.
Ex-Chairman, Massachusetts Highway Commission

PAUL D. SARGENT, M. Am. Soc. C. E.
Chief Engineer, State Highway Commission of Maine

TERM EXPIRES 1916

WM. H. CONNELL, Assoc. M. Am. Soc. C. E.
Chief, Bureau of Highways and Street Cleaning of Philadelphia

T. COLEMAN DU PONT
President, E. I. du Pont de Nemours Powder Co.

C. A. KENYON
President, Indiana Good Roads Association

NELSON P. LEWIS, M. Am. Soc. C. E.
Chief Engineer, Board of Estimate and Apportionment of New York City

R. A. MEEKER
State Highway Engineer of New Jersey.

LOGAN WALLER PAGE, M. Am. Soc. C. E.
Director, U. S. Office of Public Roads

TERM EXPIRES 1915

S. D. FOSTER, Assoc. M. Am. Soc. C. E.
Chief Engineer, State Highway Department of Pennsylvania

P. L. HARDISON
Assistant Engineer, Maine State Highway Commission

FRANK D. LYON
Ex-Deputy Commissioner of Highways of New York

JAMES H. MACDONALD
Ex-State Highway Commissioner of Connecticut

CLIFFORD RICHARDSON, M. Am. Soc. C. E.
Consulting Engineer

W. J. ROBERTS, M. Am. Soc. C. E.
Ex-State Highway Commissioner of Washington

EXECUTIVE COMMITTEE

G. W. TILLSON
E. L. POWERS
R. A. MEEKER

COMMITTEE ON LEGISLATION

W. A. McLEAN, Chairman

A. R. HIRST
A. N. JOHNSON
E. L. POWERS
JOSEPH HYDE PRATT

COMMITTEE ON STANDARDS

NELSON P. LEWIS, Chairman

HENRY L. BOWLBY
A. W. DEAN
A. B. FLETCHER
S. D. FOSTER
C. A. KENYON
W. A. McLEAN
R. J. POTTS
JOSEPH HYDE PRATT
FRANK F. ROGERS
GEORGE W. TILLSON

LIST OF MEMBERS

Active

ACKERMAN, F. W., Chemist, Barrett Mfg. Co., 86 Pierrepont St., Brooklyn, N. Y.
ADAMS, ALLISON L., Resident Asst. Secy., American Surety Co. of N. Y., 100 Broadway, New York, N. Y.
AFFLECK, B. F., Genl. Sales Agt., Universal Portland Cement Co., 208 S. La Salle St., Chicago, Ill.
AIKENHEAD, CLARENCE, Genl. Contractor, 331 Powers Block, Rochester, N. Y.
AITKEN, A. J., Iroquois Iron Works, 374 Baynes St., Buffalo, N. Y.
ALBERT, J. T., 1610 St. Paul St., Baltimore, Md.
ALLEN, JR., C. R., Cons. Engr., 172 Spring St., Saratoga Springs, N. Y.
ALLMAN, THOS. H., County Engr., Cathlamet, Wash.
ANDERSON, JAMES, Road and Genl. Contractor, Menands, N. Y.
ANDERSON, W. J., Road and Genl. Contractor, Menands, N. Y.
ANDRESEN, H. P., Sales Engineer, 139 N. Clark St., Chicago, Ill.
ANDREWS, L. F., Coudersport, Pa.
ANGELL, CHAS. A., Vice-Pres., Cranford Co., 190 Montague St., Brooklyn, N. Y.
ANNIS, ROSS E., Salesman, The Texas Co., 18 Oakland St., Natick, Mass.
ANSCHUTZ, H. E., Highway Engr., Desoto County, Arcadia, Fla.
ARNOLD, C. H., Chief Clerk, Road Dept., Allegheny County Court House, Pittsburgh, Pa.
ASH, LOUIS R., Kansas City, Mo.
ASHER, JOE, County Judge, Little Rock, Ark.
ATKINSON, T. R., Bismark, N. D.
ATKINSON, W. E., State Highway Engr., New Orleans Court Bldg., New Orleans, La.
AU, ROGER J., Supt., 54 Sherman Ave., Mansfield, O.
AYRES, E. F., Highway Engr., Oregon Agricultural College, Corvallis, Ore.

BACHMANN, FREDK. G., Secy., Markle Cement & Coal Co., Muskegon, Mich.
BADER, DANIEL S., Treas., Philadelphia Paving Co., 1345 Arch St., Philadelphia, Pa.
BADER, EDW. L., Contractor, Atlantic City, N. J.
BAKER, R. W., Contractor, 467 Broadway, Albany, N. Y.
BALL, JAMES W., Contractor, Wyncote, Pa.
BAMBERGER, M. M., Contractor, 201 N. 16th St., East Orange, N. J.
BANKS, GEO. N., Contractor, Wildwood, N. J.
BARLOW, J. E., Prin. Asst. City Engr., City Hall, Cincinnati, O.
BARNARD, F. M., Secy., Am. Assn. Creo. Wood Pvg. Mfrs., 10 S. La Salle St., Chicago, Ill.
BARNES, F. G. P., New Haven Gas Light Co., 80 Crown St., New Haven, Conn.
BARR, B. ARTHUR, Road Inspector, Anthony, R. I.
BARR, C. J., Road Material, Lebanon, Pa.
BARRETT, ROBERT, Windsor, Vt.
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PROCEEDINGS

OF

THE ELEVENTH ANNUAL CONVENTION

OF THE

American Road Builders' Association

Held at Chicago, Ill.

December 14, 15, 16, 17 and 18, 1914

together with

Reports of the Executive Committee, Secretary and Treasurer

Presented at the Annual Meeting, February 5, 1915,

Reports of the Committees on Standards and

on Legislation, List of Members, etc.

Published by the Association

150 Nassau Street

New York

GROUP OF DELEGATES AT THE TENTH ANNUAL CONVENTION OF THE A. R. B. A. AT CHICAGO, ILL., DEC. 14-18, 1914.

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*Died March 24, 1915.

The Fifth American Good Roads Congress, Eleventh Annual Convention of the American Road Builders' Association and Sixth Good Roads Show were held at Chicago, Ill., on December 14, 15, 16, 17 and 18, 1914. The total registration, which was upwards of 3,500, included representatives from practically every state in the Union, a number of the provinces of Canada and several foreign countries. The registration was the largest of any road convention of which there is record and included by far the largest number of actual road builders ever gathered together at any convention in this or any country. These road builders included state, county, town and city officials, contractors, machinery and material manufacturers and dealers and others directly connected with road and street work.

The meetings began on Tuesday afternoon, December 15, this session—the first—being devoted to addresses of welcome, the response on behalf of the American Road Builders' Association, the presidential address and other addresses. In the evening a meeting was held under the auspices of the Associated Roads Organizations of Chicago and Cook County. The technical meetings commenced with the second session, on Wednesday, December 16, and were continued through the third session on Wednesday afternoon, the fourth session on Thursday morning, the fifth session on Thursday afternoon, the sixth session on Friday morning and the seventh session on Friday afternoon. All of the sessions were held in the assembly room of the Saddle and Sirloin Club in the Stock Yard Inn.

On Wednesday evening the annual banquet of the A. R. B. A. was held in the Grand Banquet Hall of the Hotel La Salle. This year a vaudeville entertainment was added to the program, and the after-dinner speeches were purposely limited in number, as it was the idea of those in charge to make the entertainment feature the predominant one.

The Sixth Good Roads Show comprised exhibits by over one hundred exhibitors, nearly all of whom were manufacturers of or dealers in road and street building machinery or material. The commercial exhibits were divided into two classes—those consisting of machinery and those consisting of material. The former were housed in the South Pavilion of the International Amphitheatre and the latter in the North Pavilion. The educational exhibits were arranged around the arena in the International Amphitheater. In the arena itself was a paved road, 20 ft. wide and nearly 500 ft. long, consisting of sections, each from 20 to 40 ft. long, built of different materials or by different methods. This roadway was bordered by trees and sign posts, and làmp posts were set up at intervals, giving it all the appearance of an actual street.

Proceedings

of the

Eleventh Annual Convention

Monday, December 14.

The only event of the convention on Monday was the formal opening of the Sixth Good Roads Show early in the evening. President McLean made the speech of the occasion, referring briefly to the development of the association since its organization and comparing it with the growth of the good roads movement. He also announced that he had been in telephonic communication with the city officials and that although Mayor Harrison was unable to be present he wished to convey to the American Road Builders' Association assurances of his interest in its objects and to extend a welcome on behalf of the city.

Tuesday, December 15.

FIRST SESSION, 2:30 P. M.

PRESIDENT W. A. McLEAN: Gentlemen of the American Road Builders' Association: I have the honor to ask the Reverend Mr. Stafford to open the proceedings by the invocation of the divine blessing.

REV. J. P. STAFFORD: Almighty God, we thank Thee that we can expect Thy blessing upon us if we try to do good work in any way. We thank Thee for this organization; for the good it has accomplished; its aims and its ideals; for the betterment of the ways in which people live. We thank Thee that we can look up expecting that Thou dost care for the things that men do; the ways in which men live; the ideals by which they live. We thank Thee that light travels faster than darkness, and that goodness is more contagious than badness, and that Thy kingdom has meaning in this world. We thank Thee that our conception of religion teaches that Thou dost care for the things we do and the things with which today we have to do. We pray Thy blessing that wisdom and discretion may be given in this meeting, in its deliberations and its decisions. We ask that we may not merely want to do Thy will, but that light may be given to us that we may not only do Thy will but know how to fulfill Thy will. These things we ask in the

name of Him who hath loved us, Lord of Life and of Light. Amen.

PRESIDENT McLEAN: The first speaker to address you this afternoon will be the representative of Mayor Carter H. Harrison of Chicago, Mr. L. E. McGann, who is Street Commissioner of the city and former United States Senator from Illinois. I have the honor to ask Mr. McGann to address you. (Applause.)

Address of Welcome on behalf of City

By L. E. McGann

Commissioner of Public Works, Chicago, Ill.

Mr. President and Gentlemen of the Good Roads Congress and the Good Roads Association: I am here at the request of His Honor, the Mayor, Carter H. Harrison, to voice his regrets at his inability to be at this meeting, to present his compliments, and to wish this movement the greatest possible success.

The road congress indicates that the commercial world and the manufacturing world appreciate the economies in roads properly constructed—that they will provide facilities for getting the product of the field and of the factory to the market.

Our large communities throughout the United States are suffering from the preliminary errors of their organization. Sectional divisions were made, having sectional representatives, who keep in mind the promotion of their particular sections only. In the preparation of plans for improvements no attempt was made to harmonize the conditions or to have a uniformity of character of material throughout a community, with the result that each separate section makes a different kind of improvement.

In Chicago each alderman seeks to promote the welfare of his section, disregarding the character of the improvement adjoining him at all points of the ward. The result, so far as roads are concerned, is that we have a road in one ward joining a road of a different plan in another ward, and beyond that still another plan.

Our experience in Chicago may be valuable to many of you who represent the smaller towns that in a few years will rank among our great cities. A homogeneous plan, well executed, means the greatest economy, means the most rapid

development of a community, and means the highest efficiency in the disposition and transportation of the product of a community.

During the year 1914 we deliberately planned what we call a through route, or through road system, so that from center to limits, and beyond into the country, there would be better traffic facilities to the rest of the state, and so that producers could enter the city to dispose of their wares. The local roads organizations are entitled to great credit for aiding in the promotion of this uniform and consistent system.

I am looking forward to the coming year to have work extended and perfected so that when you come here next year to your congress, as I expect you will, you will find a city vastly improved.

I want to congratulate the road equipment builders on coming to Chicago. Any of the devices or any of the combinations that go to make up the cheapest road, the most enduring road, with the greatest speed, will find a ready market in this city.

We have our plans and our preference today, but we are not wedded to any. We shall be glad to recommend a method of road construction that will assure the cheapest maintenance and the most enduring construction, and that will offer the least resistance to wheeling. A thousand miles of our main highways are yet unpaved. We have 1,300 miles of highways known as alleys, that are as broad as some of the noted highways in Europe, unpaved. Our people are ready to have them paved.

The Board of Local Improvements has paved about 120 or 130 miles this year, but our wear and tear amounts to about 10 per cent. You can see that at the present rate we shall never get paved up, so I want to bid you all welcome to come on and show us how to do it—to offer us the facilities.

In conclusion, permit me to say that His Honor, the Mayor, regrets that he could not be here, and that he extends an invitation to the executives of other cities present to meet him at dinner this evening as his guests. I want to extend to all of the representatives of all the cities here a hearty welcome to the City of Chicago.

PRESIDENT McLEAN: Gentlemen, I will now ask the representative of His Excellency, the Governor of Illinois, Mr. A. D. Gash, President of the Illinois Highway Commission, to address you. (Applause.)

Address of Welcome on Behalf of the State

By A. D. GASH

President, Illinois State Highway Commission

Mr. Chairman and Fellow Road Workers: I am so closely allied to the road workers of the United States that I feel like saying on my own behalf: I welcome you with fraternal regards.

I am pleased to represent here today the Governor of the great State of Ilinois, whom I hoped could find the time to come and address this splendid assembly for and on behalf of the state, and on his own behalf, because I know that you would have enjoyed exceedingly hearing him in his happy manner of addressing the people. But circumstances over which he had no control and which called for his attention in another part of the state, make it impossible for him to be here in person.

I assure you, however, that he is greatly interested in the question of good roads. He is so interested that he called a good roads day to be set apart by the State of Illinois on the 15th of last April, and he came to the City of Chicago from Springfield on that day and made a trip from the City of Chicago to Sterling, 120 miles west, with the automobile association of this city. On that trip he made some twenty-seven speeches in favor of good roads in general and for good roads in the State of Illinois in particular. He has been one of the chief exponents of this splendid question of improving the public thoroughfares, the people's highways, as auxiliaries or feeders to the great railroad systems of the United States. He championed the passing of the good roads law in this state at the last session of the Legislature, which has put the State of Illinois in line for getting a system of better roads. I know that you would have enjoyed a welcoming address from Governor Dunne on this occasion.

Speaking of good roads in the State of Ilinois—or bad roads—permit me to say that a few weeks ago I was introduced at a good roads banquet in the City of Buffalo, as the man coming from the state of bad roads. It somewhat humiliated me, but I said:

"Gentlemen, you may introduce me as coming from the state of bad roads, but it is the only bad thing you can say about the great State of Illinois. It is first in agricultural pursuits, second in point of wealth, and second in point of expenditure of money for road improvements for the last few years, among the states in the Union. The trouble has

been that we have had no system in the past, but we passed a law at the last session of the Legislature which, if it has done nothing farther than to create a systematic working of the roads, it has done well indeed for the State of Illinois. If I come back to you twenty years from tonight and you introduce me to an audience in this city or any other city in the land you will introduce me as coming from a state with the best system of roads in the United States of America." (Applause.)

Gentlemen, we intend, in this state to make that promise good. The State of Illinois has been a little backward in this regard. It is true it is second in point of expenditures, but twenty-third in point of road improvement. The people of the State of Illinois have determined that they will not remain twenty-third in point of road improvement.

The representative of the Mayor of the City of Chicago has welcomed you to our midst, and it pleases me, a resident of this great gateway to the State of Illinois, on behalf of the Governor, to also welcome you to our midst. We are particularly pleased to have the American Good Roads Congress meet in the State of Illinois where we are starting to put our new road law into execution. After the passage of the law we had a contest upon the constitutionality of the law in every section up to 32, and that delayed us somewhat in getting started in this first year of improvement under the law. It was tried in the lower courts and won, and then appealed to the Supreme Court. The Supreme Court handed down its decision on the 17th day of June, and on the first day of July we let the first contracts for building roads under the law. The Supreme Court, by a unanimous decision, affirmed the law in its entirety as being constitutional. The law requires that 15 per cent. of the roads in the counties of the first class, 20 per cent. of the roads in the counties of the second class, and 25 per cent. of the roads in the counties of the third class, shall be known as state aid roads. The State Highway Commission, while the constitutionality of the law was being tested, together with the county officials, mapped out the roads in the various counties, connecting all of the trading points of the state with each other; so that this system of roads when once constructed will reach into every community of the state. There will not be a farmer in the State of Illinois that will reside farther than four miles and a half from this system of roads when it is once constructed. We have prepared the maps except in six or seven counties

which have refused to come in under the law up to the present time. If you will look at that map in the exhibit of the Illinois Highway Commission down in the main hall, you will see that if we construct this system of roads within twenty years, the promise made by me to the people at the City of Buffalo at that banquet, will be kept, for we will have one of the best systems of roads in the United States of America.

Under section 32 of our law, it is incumbent upon the state after the roads are once constructed, or any section thereof, to take the roads over and forever maintain them at the expense of the state, relieving the local communities of the upkeep of the general system of roads. I ask you, my friends, if it will not be beneficial to the local communities when they are relieved of keeping up those main highways? Then they will go ahead and put all of their energies on the lateral roads, and men residing four and one-half miles or two and one-half miles, or one mile or any other distance from these main roads will insist upon their roads being made better because it is always understood that one good turn deserves another.

The building of this particular system of roads in the State of Illinois will deserve another good turn, and that good turn is keeping the lateral roads in better condition. We will always have many earth roads among us, and they will be graded; they will be worked to a system that is applied to the building of these general roads. First, according to one of the best authorities on roads that I have ever heard speak on this question, we will drain them properly; second, we will grade them and drain them properly, and then he said the third prerequisite to the construction and maintenance of every class of roads is drainage. So that is the most important thing to dwell upon, the proper grading and draining, and this shall be applied under this law on all of the roads in the State of Illinois. So that with the earth roads properly graded and drained, we expect the entire system of roads to be better in this state.

It is highly pleasing to have you come to this state, as I said before, at the inception of this road work we have started. We have told the people what it will cost to build this system of roads. We have told them that it will cost to build this 16,000 miles of roads, $10,000 a mile on the outside country roads, and there will be sufficient of those to amount to $160,000,000, with $20,000,000 added to widen the highways next to the great cities like Chicago and Peoria, and some of the other cities in the state, so that this system of roads will cost the people $180,000,000 to construct. Now, that

would be a good deal for a little body of men like this to pay, but when you take into consideration the population of the State of Illinois, it will be less than $30 for each man, woman and child. We are telling the people the darkest side first, the cost of the system, and when you show them that the people can afford the system from an economic standpoint they are for it. It will cost the farmers to pay their part of the cost of these country state aid roads, only 8 cents an acre for 20 years. Thus the farmers are becoming enthusiastic on the question and many of them who are great landowners say: "We would like to pay our part of it now and get this splendid system of roads that you are talking about, at once."

Now, my friends, I don't want to take up your time too much in dwelling upon the glories and beauties of the City of Chicago and of the State of Illinois, and of what we are doing in the State; but it is interesting, I know, to all of you road men to hear what we are doing to start this splendid movement in the State of Illinois.

I saw a few days ago a little article in a Hostetter's Bitters Almanac—something that I am reminded of now. I hadn't seen one of those old almanacs for thirty years, but when I was a boy I remember of seeing in that almanac a little statement like this: "Ma, make Bobby behave himself. Every time I hit him with the hatchet he hollers." Now we are going to the people and hitting them with the hatchet of logic, and they are not hollering as soon as they find the cost of these roads, or about the probable life of the roads that are to be built of brick and concrete. I say to you that I believe that a splendid brick road built in the country away from the great centers will be there for 100 to 150 or 200 years, with little upkeep. I say this because I have seen it demonstrated that the brick pavements laid 20 years ago in towns of 15,000 or 20,000 inhabitants, and laid properly, are good today.

Now, I saw another thing in that almanac when I was a boy. Some people are trying to delay upon this question. Every man, I take it, is in favor of good roads. Every man, woman and child that knows anything about the public utility that belongs to the people is in favor of good roads, but the trouble of it is we are afraid that we can't afford the wherewithal. That is why we started out with the cost at first, and are telling the people the darkest side to begin with. But this little story was about the boy that wanted to delay. It ran something like this. It was fine literature even if it was almanac literature. The mother wanted a load

of wood and she said, "Thomas, go and bring in a load of wood." The boy wanted to delay matters. He knew the wood was valuable just as people know these good roads are valuable, but he wanted to delay a little, and so he said, "Ah, my dear mother, the grammatical portion of your education has been sadly neglected. You should have said: 'Thomas, my son, transport from the recumbent collection of combustible material upon the threshold of this edifice, one of the curtailed excrescences of a defunct log.'" Now that is the way of the people. They are simply using a little language to delay, but it is only a question of time when all of the people are going to be in favor of the construction of the entire system of state aid roads of the best material. They are all now in favor of the construction of a good quality of road, and oftentimes in going over the country as I have, and talking this good roads question I have found some men who say they are the original good roads men. Why, they forget that even Babylon and Nineveh in the Valley of the Euphrates and the Tigris, were joined with all of the other cities of that day by a system of hard roads, a thousand years before Abraham was born. They forget that the Israelites, when they marched out of bondage in Egypt, marched over a stone road as far as the Isthmus and could have gone on over a system or roads built at an earlier date but the Phoenicians objected to such a mob passing through their territory. They forget that the Romans built 50,000 miles of stone roads in Europe in their day; that they built some of the best roads that were ever built by men; that even the American Indians built 1,700 miles of stone roads; that the Peruvian Indians built roads in the countries they had conquered. This thing of road improvement, gentlemen, is as old as civilization itself. I need not tell you roadmen, who have been studying this question all of these years, these things; or preach in favor of good roads. These are matters which are so patent to us who are studying the question that we want them to spread to all of the people and be catching among all the people in the United States. You are here in the great State of Illinois where I came from, and here is Mr. Wilson and Mr. Bradt, and other men who are laying their heads together to make the promise good that I made to the people of the United States, and to the people of the State of Illinois in particular that they may all catch the enthusiasm and that we may go forward to better things. And those better things are the building of good roads throughout the length and breadth of the state that all the people may get better acquainted. You like each

other when you know each other better. You like me much better because you have seen me here today. So with our neighbors. When they communicate with each other, men grow wise. We grow wise when we communicate with each other through the medium of our writings and through talking and conversing upon various questions. We grow wise on this road question and the building of good roads by listening to or conversing with each other and laying our heads together as to the best plan. So that, gentlemen, it gives me particular pleasure today to welcome you to this state on behalf of the Governor, and on behalf of the people of the great State of Illinois, who receive you with open arms. The Mayor of the City, through his representative, has said to you that you are welcome, thrice welcome, to the City of Chicago, the third city of the earth.

I thank you. (Applause.)

PRESIDENT McLEAN: It has been a pleasure to know what the City of Chicago and the State of Illinois think of the road associations, and what they propose to accomplish. But however much they may undertake to do it is safe to say they will be unable to do it all.

It is fitting that we should hear the Assistant Superintendent of Schools, of the City of Chicago, Mr. John D. Shoop, who will now address you. (Applause.)

Address of Welcome on Behalf of the Association of Commerce.

By JOHN D. SHOOP
Assistant Superintendent of Schools, Chicago, Ill.

Mr. President and Members of the American Road Builders' Association: It is my pleasure to greet you today under the auspices of the Chicago Association of Commerce and to bid you welcome to the confines of this great city. I am always pleased to meet and to mingle with men who have vision, men who are responsible for the agencies that are essential to perfect the greatness of our nation. We remember, and it has already been mentioned today, that the great Roman general, when he laid anew the foundations of the Eternal City proclaimed not only that all roads should lead to Rome, but that they should be constructed after such fashion that the intercommunication between the city on the Tiber and its subsidiary provinces should be such that the people of the provinces might the more easily inter-

mingle. Here lies one of the greatest benefits resulting from the construction of good roads, the bringing of the people of the different parts of the country in closer and more sympathetic relation. If you analyze the difficulties of humanity, be they individual, provincial or national, they resolve themselves into one of two elements, either they are traceable to ignorance, or they spring from the soil of selfishness. The greatest agency in the world for relieving the social order of these evils and for bringing people into closer communication is to make the lines of travel suitable for the intermingling of the masses. I venture to say that there is scarcely an individual here today who does not believe that if in the earlier history of our country lines of communication had been established between the North and the South, as well as between the East and the West, one of the greatest national calamities might have been averted. We need to know each other better.

The problem that has already been suggested to you is one not only of economy, although in that we find ample argument sustaining the great movement for the building of better highways. The great question of the day is not alone that of a production that will balance with the demands of consumption, but it is a question of transportation, the diminishing of lines of resistance between the producer and the consumer, the constructing of channels for conveying with least friction possible the commodities of the farm to the city where they are needed. In preaching the gospel of good roads we are encouraging a policy which will help to relieve the tension of our economic situation and assist in solving the problem of what we hear so often mentioned today, the question of excessive cost of living.

But there is something in addition to the economic phase that I wish to present to you, and that is the educational factor. You are aware that there has been an educational awakening within the confines of our own commonwealth. We have decreed that high school possibilities and high school privileges shall not be reserved to those who have these privileges at their door. By the recent decrees of the lawmakers of this state it has been determined that every boy and every girl who qualifies under the patronage and the support of the township in which that child is living, shall have the benefits of a secondary or high school education. In order to make this possible, in order that the star of hope may continue to shine above the cradle of the poor man's babe, we must pave the way between our educational centers and the modest home in the rural district that there

may be equal opportunity for all the children of the commonwealth.

I want to speak today, then, in behalf of the Illinois boys and the Illinois girls in the more remote portions of our territory. Let us look well to it that there shall be that equality of privileges, that parity of opportunity, which will provide for each child as nearly as possible an equal point of vantage in the care and protection which the state offers to its wards. Good roads are essential in making effective this policy. And, again, some time ago I was trying to fill an engagement in a city down in the state, and I engaged a chauffeur to drive me across a stretch of territory in an automobile. When we had covered a little over half of our distance the automobile went down in the mud, and for hours we labored to extricate that machine from the mudhole. I am certain that if you could have listened to the language of the chauffeur on that occasion, you would have decided that the good roads movement is not only an economic and an educational proposition, but I believe that you and the eminent divine on my left would agree that it is a religious proposition, as well. (Laughter.)

Some one has said that this cannot be done in a provincial way. It is true. What we need today, is men who have vision. Emerson tells us in one of his essays, that "Smith owns this farm, Brown the second, and Jones the third, but no man owns the landscape." It is the landscape view that we need; the vision that is unrestricted by sectionalism and provincialism, that view that extends beyond the limits of your farm and my property and which includes in its scope the domain of your neighbor, and that of the state and of the nation at large.

The question is one of inoculation. If we but plant the germs, the seed here and there, they will eventually grow into more comprehensive proportions. Some time ago I was in the state of Missouri and a gentleman showed me a wide expanse of blue grass territory. He said to me, do you know how this came about? Many years ago my father came to this country when these prairies were covered with wild grass, and one day he bought a bushel of blue grass seed and strapping the sack over his back he rode over this territory scattering here and there a handful of the seed. It took root and began to grow and to drive out the wild grass, and ultimately by the expansion of these little patches they finally touched edges and you see the result. Wherever there is one in this convention who can carry away something of the spirit of your assembly, wherever there is one who can

plant the germ of better living, of greater, nobler possibilities for our great commonwealth, from his abiding place as a center there will be created an area of interest that sometime will touch edges with other territories that will have been vitalized by others of this group and lo, the work is complete. To this task we are committed. To this work we will drive our energy with the belief that in the years to come boys and girls who, in turn, are to assume the reins of government in this nation, will look upon this labor of yours as a monument to the wisdom of their fathers.

In that spirit, then, we meet today. I would have you feel that while you are within the confines of our city you are with people whose hearts beat in unison for the accomplishment of that which is best for the city and for the nation. I wish that you could know more of the Chicago people. I wish that you could know more of Chicago's aspirations and visions. I wish that you might see not only her skyscrapers and boulevards, but her parks and playgrounds, her school houses, and the agencies that her people have created for the betterment of human conditions, for I am certain that you would carry away with you as the result of your observation, new aspirations and new determinations to make these conditions widespread throughout the nation. May there arise from this great nation a beacon light whose penetrating rays shall reach to the uttermost parts of the earth, exemplifying that which is best and that which is noblest in the building of political and social structures for the benefit of the world at large.

Again, I welcome you in the name of the Association of Commerce, an organization which is sympathetic toward every movement that is instituted for the ends for which we have spoken and whose cooperation and whose assistance you will ever find at your command. (Applause.)

PRESIDENT McLEAN: Gentlemen, it is a pleasure for me, on your behalf, to take this opportunity of thanking the City of Chicago, the State of Illinois, and the Association of Commerce for the hospitality which they have extended to us.

In anything which they have said of the city of Chicago and this state, they have, I believe, been extremely modest. The city of Chicago is one of the marvels of this continent, and I say it seriously and earnestly.

Only one hundred years ago Chicago, the site on which we are standing, was the home of Indians in their savagery. Forty-three years ago, Chicago had only 300,000 population.

To-day, it has approximately ten times that. Is not this something striking? Does not this emphasize the great potentiality of this entire country? It is said that one of the early explorers who passed through here, pointed to the site and said that here was the gateway of an empire, here the seat of commerce and that the men who would make their homes here would have to be men of action. That has proven true in a most remarkable way, and if I search for the cause of this great development of the city, I believe that it is due more to its location with regards to transportation than to any other cause.

We here are men who are interested in transportation and what we have to say ought to be of interest to the City of Chicago. A distinguished American has said: "Close up the common highways of a country and the steam railways will pass out of existence, and your steamships will decay at their moorings." The common highways of a country are the important fibers which extend out and grasp the soil and draw to the roads on which we have been expending so much and to the steam highways, that sustenance which has created Chicago.

The City of Chicago is interested not only in the roads of Cook County, nor in the roads of the state of Illinois, but in the roads of California and of Oregon and of Canada, because the traffic from all of these parts comes through here.

We hear a good deal of colonization. We apply it to new and unoccupied territory. The great resources of this country haven't been scratched. Right in the heart of our most thickly populated country there is ample room still for colonization and the means to it are good highways.

This Association which meets here today is not an association primarily of road boosters. We are technical men and practical men who are actually engaged in the construction of highways and what we have to say will be, I trust, to the good of Chicago ultimately.

I thank, very heartily, the representatives of the corporations which have spoken to us for their very gracious and kindly welcome to this city. It is customary on occasions of this kind for the President to introduce proceedings by something in the nature of a serious talk. Our time has passed, unfortunately, this afternoon. The paper which I would have presented to you is in print. It will be available to you, and I am sure that under the circumstances you will permit me to pass it over as having been placed before the Association in the usual way.

[NOTE: President McLean's address follows.]

Road Improvement.

By W. A. McLEAN
Commissioner and Chief Engineer of Highways for the Province of Ontario, Canada

Presidential Address

The present era is remarkable as one of rapid and convenient travel, transportation and communication. In this it is distinguished from all preceding ages. Invention has shown more marked advance in this phase of modern civilization than in any other. Every refinement has been sought, and vast expenditures have been made on steam and electric railways, ocean and lake steamship lines, harbors and canals, express, postal, telephone, telegraph and cable services. The motor vehicle is becoming a necessity for the transaction of business and even the air has been conquered as a practical medium for human locomotion. All these have not lessened but rather have increased the need for better common roads, and the demand for their improvement is accumulating with marked intensity.

The road situation of today presents many problems. It is doubtful if road conditions will ever be without their problems, for changes are constantly taking place, requiring an equivalent adjustment in methods of dealing with them. But it is also true that the present generation has opportunity to advance in this regard far beyond reasonable heritage or desires—for in general common road construction has been neglected, has been sidetracked and forgotten in the hurry of railroad construction.

New demands are pressing; advanced methods of construction are needed; old systems of organization are inadequate; old abuses and prejudices are persistent; opportunity for reform and progress is abundant and urgent.

The work of this Association, and particularly that of the annual convention, is to its active members a matter of continuous but ever-reviving interest. Until the last ten or fifteen years, road construction in the open country was well served by water bound stone and gravel, and was governed by established practice. Roads were built for horse-drawn traffic only and the weight of loads was comparatively light. With the general use of rapid motor vehicles an entirely new form of wear has been added to that of steel tires and steel-shod horses; the weight of loads has largely increased, placing a much greater demand on road foundations and on bridges; the use of roads has greatly increased, especially on highways carrying suburban and interurban traffic. Road building is

in a reformative stage, and the annual accumulation of experience is steadily shedding new light on a very complex problem.

The growing difficulties of road construction and maintenance are not without their reward. The increased *use* of the roads means their increased *usefulness.* The possible service that may be performed by the common road is in proportion to the efficiency of the vehicle. The motor passenger vehicle and the motor truck have greatly advanced the general public value of the common road; and whereas good roads were regarded, a few years ago, as solely of rural concern, urban centers have become keenly alive to their value, and are willing to bear a fair proportion of the cost. The value of roads as a means of travel and transportation has increased manyfold. Instead of the farming population being expected to meet the entire cost, it is now fully conceded that, as regards main roads, cities must share the *burden as with any other* department of transportation.

Correlation of Facts

The number of elementary materials used or dealt with in road making is strikingly few, and, with minor exceptions, these materials are included in a brief list—sand, clay, gravel, broken stone, asphalt, tar, oils, vitrified brick, creosoted wood, stone setts, and Portland cement.

To these may be added a few materials of local service such as oyster shells; or proprietary binders, such as Rocmac or Glutrin. While the elementary materials are few in number, the range in quality is wide, their combinations are many, conditions of traffic are of varying degree, and such factors as climate, workmanship and cost must be considered.

In the solution of road problems, at the present time, effort should be largely given by scientific engineers to the accumulation of facts respecting road materials and their action under climate and traffic. Much has been done in the past five years in this regard, and it is confidently expected that the next five will do more. Experience will then more nearly approximate the anticipated life of new materials and new methods. The status of knowledge respecting road construction in the next five years will largely depend on the care and thought with which we, at the present time, assemble and correlate obtainable facts. This is a matter which should be especially impressed upon municipal bodies, and cooperation with their engineers obtained, in order that experiment, test, and the collection of data may be effectively carried out.

Roads should be built according to traffic. To a proper

solution of the problem of road construction and maintenance, there is much need of the general acceptance of uniform traffic standards. Traffic, in relation to the results from a paving material, is sometimes loosely described as "light," "medium" or "heavy." These terms have all grades of meaning according to locality. In one district 200 vehicles a day would be considered heavy traffic, while in another 2,000 vehicles might be medium traffic. When traffic standards have been clearly defined, and data is accumulated as to behavior and cost of a material under definite degrees of traffic, our experience can become of much greater usefulness. What is needed is a greater accumulation of fact, correlated with definite standards of traffic.

Work Should Not Be Delayed

Road building is a slow process. In the northern states and Canada there are only about one hundred actual days in the year to be fully depended on. A mile a month for six months of the year is reasonable progress for one outfit of machinery.

There are limitations as regards labor and material which cannot be exceeded without greatly increasing the cost of the work. If a community needs a good general system of roads today the work should have been commenced twenty years ago. If a system is needed twenty years hence, it should be commenced now.

Permanent Roads

The term "permanent" as applied to roads is somewhat misleading, and is not always appreciated by the general public. In the full sense of the word, there is no such thing as absolute "permanency." It is merely a relative term: But it is important, in making safe provision for financing road undertakings, that the matter be clearly understood. For all practical purposes, expenditure for the purchase of road allowance may be regarded as permanent; earthwork and certain drainage of an adequate kind may be regarded as permanent; substantial concrete culverts and bridges may be regarded as permanent; heavy road foundations may be permanent. But there is no such thing as a permanent road surface. Traffic and natural disintegration cause the wear and decay of any road surface that can be employed, and adequate provision should be made for the repair and renewal of the surface.

To meet the immediate needs of traffic throughout the United States and Canada, a large amount of construction must necessarily be carried on that cannot be considered of a

"permanent" kind. To attempt the task of immediately building, for all traffic, roads that would have a maximum of permanence would be as impossible as it would be economically unwise. A large part of the farm traffic can, for the present, be best served by roads of moderate cost, lightly surfaced with broken stone or gravel, but carefully graded and drained. In many localities even good earth roads (but well graded and drained) maintained by use of the log drag must be depended upon to meet the needs of traffic, owing to sparse population or the absence of local gravel, stone, or other suitable surface material.

The most unfortunate results have, however, arisen in the treatment of main roads on which, though expensively built, an effort has been made to maintain a heavy bituminous or other high-class surface on a totally inadequate foundation.

Much discussion has taken place during the past year on the subject of road foundations, and has arisen largely from those who attended the International Road Congress in London last year, as a result of their observation of practice in Great Britain and in Europe. European practice in all classes of permanent road construction has undoubtedly in the past tended to greater mass in the foundation than has been generally adopted on this continent. If past practice abroad has proven the need for the massive foundation, it would seem that, on this continent, the use of light foundations should be critically considered, with a view to the adoption of a greater depth of stone and the more general use of Telford or equivalent foundations, particularly for main roads, on which heavy traffic is assured. In the construction of strong foundations there is opportunity for permanency, which will at the same time reduce the cost of repair, for a large outlay may readily arise from attempts to maintain a good surface on an insufficient and yielding foundation.

Fair Distribution of Cost

A fundamental necessity in creating a system of roads is that the cost shall be fairly and equitably levied on those who benefit. Failure to do so has done much to retard road building in the past. If the general public feels that the cost of roads is borne in a reasonable degree by those who should contribute, much opposition will vanish. If the farmer feels that he is being asked to build roads for motorists of the cities, he is naturally opposed to proposals for road development on such a basis. Out of this has grown much of the opposition in some localities to the construction of trunk and state roads. A close study of the farmer's viewpoint by advocates of trunk roads will throw light on the road situa-

tion as a whole, and will indicate that a successful road policy in any province or state should make provision for the improvement, if not of all roads, at least of those more directly serving farm traffic. Broadly, trunk roads run from city to city, and are commonly parallel to the steam railway. The market roads, on which rural traffic most frequently concentrates, radiate from the stations, villages and shipping points, and are, in general, at right angles to the trunk roads so often advocated for motor traffic.

Trunk roads are a necessary adjunct of any system of roads. They are desirable, and should be built. They frequently form part of a system of local market roads, but must be more substantially built to serve the more severe traffic.

It is difficult, however, for even the most patriotic farmer to rest satisfied with beautiful pictures and illuminative newspaper descriptions of the splendid roads of his own state—roads he never sees—while he has still to drive through the mud axle-deep to his local market or shipping point, with nothing being done to remedy that condition. Rural residents of every good farming community want good roads, and are willing to meet a reasonable outlay for them—nor are they opposed to trunk roads if the cost is levied upon the proper source.

A farming community, in so far as is consistent with its prosperity, can fairly be asked to contribute such amount per mile of road as would properly meet the needs of local traffic. For more expensive construction for motor traffic the remainder of the cost should be met from a source representing the contribution of cities or other communities benefited.

Market roads without trunk roads are commonly opposed by cities quite as much as the farmers oppose trunk roads when provision is not made for market roads. Upon a plan of road improvement which includes both, all the people can agreeably unite.

It is not intended to convey the impression that all roads can be built at a stroke, and that a durable road can be at once built to every farmer's gate. There must be a starting point. For this purpose certain roads must be selected for the immediate improvement, others to take their turn later. A study of local traffic conditions will indicate the roads on which traffic seeks to concentrate, and, commencing with these, the general system can be developed from year to year.

There should be no conflict of interest between the two classes of roads. The one is a necessary adjunct of the other in a complete system of roads. The great need is that the value of both should be recognized and adequate measures

taken to develop both concurrently; but there should be no effort to substitute one for the other.

Bond Issues

Much difference in opinion and practice exists with respect to the issuance of bonds for road construction. At one extreme are those who oppose all bonded debt for public roads, while at the other are those who advocate bonds maturing in forty and fifty years. It is probable that, as in most cases of widely divergent opinion, the true solution is in a moderate middle course.

The primary construction of a great system of roads has, in all countries, required large initial expenditure, such as can only be procured by distributing the repayment over a term of years. The construction of main roads, and even good market roads, is as a rule carried on in very disjointed sections, and at a sacrifice of workmanship, if the cost is provided by annual levy only. The necessary initial outlay can, as a rule, be sustained only by borrowed funds.

It may be asserted as a further truism that the term for retiring the bonds should not exceed the useful life of the work. Again, repayment in the briefest possible period is favorable in that the total interest charges are reduced.

In considering the matter, the road structure may be divided into several portions:

(1) The system of drainage;
(2) The earth subgrade;
(3) The foundation;
(4) Bridges and culverts, and
(5) The wearing surface.

Judging the future by past experience, it may be estimated that long-term bonds for certain portions of the work are justifiable. An effective system of open and underdrains, deep cuts, extensive fills, and an adequate width of earthwork; a Telford, concrete or other heavy foundation; concrete or heavy steel bridges and culverts are all of long durability, and may justify long-term debentures. The road surface, on the other hand, has a comparatively short life, and will seldom justify a debt of more than five or ten years' duration. Adequate maintenance is in all cases essential.

The methods of finance as regards the issuance of bonds may thus be based on the life, not of the surface only, but of the several portions of the structure; the bonds for surface costs to be retired in not more than five or ten years, while the long-term period may be applied to what may be more truly termed the "permanent" portion of the work.

It might be logical to approach the matter on the basis of

a general estimate, meeting a proportion of the cost, approximately 50 per cent., by long-term bonds, the remainder, or 50 per cent., covering surface costs, to be retired, according to the life of the pavement, in from five to ten years.

To go even further on the ground of safe finance, and to pay something for immediate benefit, a portion of the cost might be met out of the annual levy; but that as a rule is difficult, and may tend to reduce the amount available for adequate maintenance. It need not be added that to meet the cost of maintenance by the issue of bonds should be regarded as a criminal method of finance.

Town Planning

Town planning is a matter with which road builders, we believe, should be closely identified. In this let us not be misunderstood. By "town planning" we do not mean the preparation of artistic plans and beautifully imaginative reports frequently employed for municipal advertisement and the promotion of speculative subdivision schemes.

The essential principles of town planning are largely based on adequate provision for present and future traffic requirements, together with subordinate matters of street and road design.

The question of town planning is one which should arouse interest in every progressive town and city. The United States and Canada are passing through a period of growth and expansion which, we trust, may long continue, and proper foresight in this regard is a necessity.

The past tendency to allow towns and cities to follow unguided growth has resulted in many objectionable and unfortunate conditions which could readily have been avoided, but which may now only be remedied at much expense.

The Housing and Town Planning Act of England, a recent measure, is accomplishing much, in enabling landowners and municipalities to enter into agreements for mutual benefit. Main and radial thoroughfares are provided, parks and open spaces are laid out subject to agreement, industrial areas are set apart, residential districts are fixed, and streets, drainage, grades, water supply and many other details are decided upon in a manner that gives every opportunity for favorable and least expensive growth. The advantage to both the public and the landowner is apparent.

No doubt many towns and cities on this continent, now comparatively small, are destined to a very considerable growth, and by well-devised measures, the gradual widening of existing streets, the opening of new streets, grouping of public buildings, etc., could be provided for; so that town

planning may be applied not only to new areas, but to the favorable treatment of old districts and the removal of existing defects. Practical town planning is of much value in meeting the present and future traffic needs of urban communities.

Present Financial Influences

The influence of the war on the financial situation is a feature of much importance as regards the present and immediate future of road building on this continent. On the declaration of war by European powers in August last, while much uncertainty was felt, there was remarkable freedom from panic in the money markets of the world. Since the commencement of hostilities there has been a decided improvement. Crops, on the whole, in the United States and Canada have been good, and farmers are receiving good prices for their produce. While the flotation of municipal bonds is difficult, and capital is showing a natural timidity, there is a growing tone of optimism which promises much.

While municipalities and state governments of the United States are feeling the effect of war conditions, Canada is more directly influenced, and is, at the same time, meeting a heavy war expenditure.

The borrowing opportunities for Canadian governments are restricted, and while loans for large undertakings are seriously handicapped, means are being developed through local capital to meet necessary and desirable outlay.

The construction of roads for war relief has been largely accepted as a logical measure, and while rural municipalities, with a continuance of good crops and prices, will be in an excellent position to carry on the work, the ability of provincial governments to aid large undertakings may not be correspondingly favorable. Here private capital has, in at least one marked instance, stepped into the breach, and the construction of a concrete highway from Toronto to Hamilton (about 40 miles) has been organized and commenced since September 1st. A proposal to construct a main road from Montreal to Windsor, across the Province of Ontario (over 500 miles in length), as a great memorial to the Canadian expeditionary forces, has been received with much public favor, and it is not improbable that construction may be commenced as a war relief measure.

The final effect on road construction must largely depend on the duration of the war. Should the struggle, with its tremendous waste, be prolonged for three years, as is predicted by an eminent authority, the ultimate influence on financial conditions is impossible to estimate. Should it be concluded in a year, as many hope, the present feeling of

optimism will assuredly not be without substantial foundation.

We will now have the pleasure of listening to the Minister of Public Works for the Province of Ontario, Mr. Finley G. MacDiarmid. (Applause.)

Address by Finley G. MacDiarmid.

Minister of Public Works for the Province of Ontario, Canada

I am sure, Mr. President, and Ladies and Gentlemen, that I consider it not only an honor, but a privilege to have the opportunity of saying a few words to those assembled here this afternoon. In the first place, I wish to congratulate you upon having enlisted the sympathy and cooperation of so many ladies as I have seen this afternoon, not only at this meeting, but at the exhibit in the other building.

Now, I am sure it is unnecessary for me to take up any of your time here this afternoon. I appreciate the welcome that has been extended to all by the Mayor of the great city of Chicago and also by the representative from the state of Illinois. I appreciate it perhaps more keenly, more thoroughly, than some of you coming from states of the Union, coming as I do, from the great Province of Ontario—the province lying adjacent and bounded by the international waters of Superior, Huron, Erie, Lake Ontario and the St. Lawrence River. Coming from that great province to take part in this convention I appreciate most highly and most deeply the kindly welcome that has been extended to us, as citizens of the greatest province belonging to the vast Dominior of Canada, who have just completed 100 years of peace between the two greatest people on earth. Only last week, in the city of Toronto, we had the opportunity and privilege of entertaining the peace delegates from the great State of New York, who came to arrange something suitable to commemorate the centenary of peace between the British people and the people of the United States. We respect the flag which floats over your homes because we believe it stands for liberty and for freedom. We have enjoyed that same liberty and freedom beneath the folds of the Union Jack. The ideals of the two peoples are the same. We are here today to profit by your experience. The last time I was in the great city of Chicago it was as a member of a commission looking into the question of prison reform. We found, on that occasion, a great institution in the state of Ohio, in the city of Mansfield, after which we have molded and fashioned our penal institutions in the banner province of On-

tario. If I could feel confident that we would go back from this convention reaping the same benefit that we did in connection with our investigation into the question of prison reform, I would be delighted indeed.

Now, I am not here to speak as a technical man. I appreciate this great movement. I know that it has gripped the American Continent. Our problems in connection with the building and maintenance of good roads are perhaps greater in number than yours. But difficulties were made to overcome. Our density of population in the province of Ontario is not so pronounced, but we are trying to meet the situation as best we can. We appreciate the vital connection that the good roads movement has with the rural life of Ontario as it has with the rural life of the great Republic of America. Anything which we can do to make attractive, to build up contented homes among the agricultural classes of people is a duty that we owe to ourselves and owe to the state. High prices alone are not a sufficient attraction to keep people on the farm. They must have conveniences. They must have easy facilities for transportation. Today we have passed that stage where it is necessary any longer to discuss the economic problem. Men of all sorts of public opinion admit the necessity for better roads than we have. We have reached that stage where now we have to discuss and provide the ways and means, to decide the kind and class of road that is best suited for our particular needs, and then to make provision.

We in the province of Ontario are assisted by the county organization to the extent of one-third of the cost of building and constructing the roads. We have now before us a report of commissioners who examined into the whole road problem during the last year. Their examination was not quite completed when the great war in which our empire is now engaged, was declared, which interrupted the work to some extent. But we have made progress to the extent that we are today assisting to the amount of one-third in this county movement. The report of the commissioners not only recommends a substantial increase by way of state or provincial appropriations, but also it grapples with the question of maintenance. During the next session of the Legislature, we expect some advance will be made, some legislation will be introduced, the nature of which I am not in a position to say at the present time—nor would it be proper to do so before the meeting of the Legislature—but we expect to make an advance along that line.

Now, Mr. President and Gentlemen, I had not intended to

speak even at the length I have here this afternoon. I appreciate the warm welcome that has been extended to me and trust that the future holds a bright career for the association.

PRESIDENT McLEAN: Gentlemen, I am anxious that you should hear a distinguished citizen of Canada, Mayor Hocken, of the City of Toronto, who will speak to you a few minutes. (Applause.)

Address by H. C. Hocken.

Mayor of Toronto, Ontario

Mr. Chairman and Gentlemen: I am pleased to find in the chair one of our own citizens of Toronto, one of my constituents I might say. I am going to claim that he voted for me, even if he didn't. (Laughter.) I know he is an intelligent man, and I got the intelligent vote. (Laughter.) Or, if I didn't I should have gotten it. (Applause.) I feel very proud that this organization has honored Mr. McLean, who is so well known and so highly thought of in our own city; and not only in our own city and the province of Ontario, but over the whole Dominion of Canada; a man who has done a great deal of good, and given a great deal of study to this work, and a man whom we think is very capable.

It occurred to me, Mr. Chairman, as I listened to the speeches, that after all when we get down to this good roads question, it is a matter of service. It is the duty of the Government to make it possible for every class of community to give to every other class the full measure of service of which each is capable. I speak of our own country when I say that at least two months of the year—and I think in some places even three, and a longer period than that—the agricultural community is unable to get in frequent touch with the towns and cities of our province, and it is because of the lack of good roads. Mr. W. F. MacLean, who is sitting in the Dominion Parliament, and who is one of our farmers' representatives, a journalist and several other kinds of a man rolled into one, said to me recently that the greatest enemy of the province of Ontario is water, because the water gets on our roads and it detaches the farmer from the city. For three months in the year the farmer is isolated. Now that is practically the case; it may be a question as to the exact time, but the farmers are practically isolated from urban life for a period of two or three months. Under such circumstances it is absolutely impossible for them to render the

service to the urban communities that they could under better conditions. It is up to us who live in the cities to join with those who live in the country and construct main highways all through our states and provinces. We have spent hundreds of millions of dollars—in fact, the Dominion of Canada has given away hundreds of millions of dollars—to build steam railroads all over the country. That is very desirable. We can't get along without steam roads. We have international steam roads. You can get on the Grand Trunk in Chicago this evening, and get off tomorrow morning in Toronto. But we haven't got any international tote roads that I know anything about. There has been no attempt in Canada to build inter-provincial roads, as we would say in our country, or inter-state roads, as you would call them. Our failure to deal with this question is a reflection upon the public men and the public bodies of our country. (Applause.) To what extent it is a reflection upon the public bodies of this country I am not going to say, because I am a guest on this occasion. But is it not a fact that we have gone on subsidizing railroad corporations, putting hundreds of millions of dollars into that form of transportation, and we have neglected what is the primary method of transportation all this time? I submit to you that one of the advantages of civilization—one of the primary evidences of civilization—is good roads; and yet we haven't got them on this continent to any great degree.

Conventions such as this give us an inspiration to go back to our own community, whether it is a city, or whether it is a township, and enthuse those about us who have to undertake the responsibility of formulating the plans and agitating for their adoption. We must arouse those who have to pay the taxes, and afterwards to meet the costs. That perhaps is the first step towards the realization of the great purpose that is underlying this convention. I am sure, Mr. President, that that will be one of the results of this convention.

I have attended a good many conventions in the United States during the last ten years since I have been a member of the municipal government of our city, and I want to say to you gentlemen that the visits made by myself and other members of our civic administration have resulted in great benefits to the people of Toronto. For instance, I think our first visit to a playgrounds convention was in New York. We went home and we opened up five or six playgrounds. We got that idea from New York. We went to the city of Cleveland, and we found there an industrial farm where con-

firmed drunkards and first offenders were taken out to work on the land instead of being put in a cell. As a result we have spent $500,000—$300,000 upon land and $200,000 upon buildings—and we are taking our first offenders and drunkards out there. We owe that to the state of Ohio. We have adopted a great many other things which we have learned from visits made, and information we have gained from these conventions in the United States.

We class ourselves as one of the second class cities of the North American Continent. In Canada we don't recognize any international boundary in civic progress. We are Americans just as you are. We live under a different flag. Our flag is a little different in shape, but it has the same colors. Our form of administration is a little different; but I tell you, gentlemen, there is just as much liberty there as there is here, just as much liberty here as we have over there. We are a great democratic continent, divided by an imaginary line, and that line will become more imaginary as time passes. As our boys come over and take your girls to Canada, and your girls come over and get our boys to come over here, as we all mix up socially, commercially, financially, and every other way, except politically, we will come to be a great community working together for the benefit of the people of America. That, after all, is the thing that ought to be done. We take our inspiration from your cities. We hope we have something to show you. In fact, Mr. Chairman, I am very proud of the fact that since I came to Chicago yesterday, several gentlemen have told me that they visited Toronto last summer to inspect our harbor, and thought it was one of the best that they had seen, even after they had traveled over as much of Europe as the war would permit them to. We are very proud of that; we regard that as a big thing. We have a great harbor. And the Chicago representatives learned something from it. That does us more good than you can imagine, because we have got so much good from you. I hope, Mr. President, that this good work will go on, this international exchange of ideas will continue, and out of it will come, not a hundred years of peace such as we have had, but a thousand years of peace on the North American Continent. (Applause.)

PRESIDENT McLEAN: Gentlemen, the world is becoming smaller every day. We have heard from the extreme North and I wish to hear from the extreme South. I have pleasure in asking the Mayor of New Orleans, Mr. Behrman, to speak to you.

Address by Martin Behrman.

Mayor of New Orleans, La.

Mr. Chairman, and Gentlemen of the Convention: When my people learned that this convention was to assemble in this great city of Chicago, they asked me to come and be a part of that convention, and to be inoculated, as was said here today, with the things that you are doing in the way of road building throughout this country.

It is true that we have not progressed as rapidly as we would like to have done in the matter of roads, but then there is a reason for it. It is not necessary to go into history and tell the reason, because it is patent to every man who knows the conditions down in our section of the country for years and years. We don't like to talk of the things of the past. We want to talk of the things that are and the things that are to be. If I would speak to you, my friends, and give you reasons why we haven't progressed faster on road building, I would tell you that the war and the reconstruction days that came afterwards, and floods and pestilence that we have to fight were enough to keep any people down except the brave people that I represent here today. (Applause.)

But, my friends, all those things are in the past, and today the great city that I have the honor to represent, and the great state of which we are a large part, are up and doing. They are building, my friends. Why, the city I live in and represent here today, only two years ago voted a tax for good roads, a tax levied on every piece of property within the city limits, not one dollar of which is to be spent within the confines of the city, but to be spent in the country contiguous to New Orleans. We did that, my friends, because we felt that if we were to have a great city we had to have a prosperous agricultural community contiguous to us, and for that reason we are bending every effort to develop the highways and by-ways leading into that great city.

It is a wonderful city, the city of New Orleans, one of the oldest cities in the country. I came to be inoculated with the spirit of doing things and building good roads because I love to be amongst builders and not destroyers. My friends, it is easy to destroy, but it is hard to build up. A very little dynamite will blow down one of your mammoth skyscrapers, but how much time and energy and money would it take to put it up again? And for that reason I

am delighted to be amongst the men who form this convention today because they are builders and are doing things.

The City of New Orleans is one of the oldest cities on this continent—a city whose topography and soil conditions were originally such that the wise men shrugged their shoulders saying: "It can't be done"—that essentials like sewerage and drainage were out of the question and that filtered water was an impossibility. But there is a new spirit down there, and we don't say any longer, "It can't be done." We say, "It shall be done," and it is done. And so the difficulties attending the construction and installation of these indispensable adjuncts to the substantial growth and general development of a great city have been successfully solved in the operation now of the three finest systems of sewerage, water supply and drainage to be found anywhere.

I appreciate the courtesy of the distinguished gentleman who presides over this convention in permitting me to address you, and if I may have your indulgence, I would ask permission to invite you to come down to that city, and I only do it at this time because an urgent telegram calls me home tonight. I want you to come down there to help my people, to give them the knowledge that you have acquired in building roads because we are very much interested in that problem today. We are interested in the problem, as I told you, of bringing the folks of the country closer to the city. We want to help them, believing they are doing a great work, and we believe every city and country that does that kind of work is engaged in a splendid work because the "back to the farm movement" is bound to come.

The great cities of the country are getting too crowded and we want the boys to go back to the farm. You have got to make the farm attractive, though, and you have got to make the conditions surrounding that farm attractive, so that they will stay there. The telephone has done a great deal to help farm life. Rural free delivery has done a great deal, and the only thing now, my friends, to make it what it ought to be is the improvement of the roads, so that the prosperous farmer who wants it can have quick communication with the city. That is my plea to you, to come down to my city. We come to you as a representative of 400,000 people.

I was very much impressed by the gentleman from Chicago who spoke about the patch quilt work of Chicago.

It is not true alone of Chicago; it is true of all the cities of the country where you have ward representation. The man from the tenth ward wants his ward paved one way, while the man from the fifteenth ward wants his ward paved another way, and you never can get the results that ought to be had. But, my friends, today I come to you as a representative of the commission form of government; we have four commissioners besides the mayor down there. It is the largest city in the United States today under the commission form of government, and I speak to you as a man who has served as mayor under both forms of government, and am happy to say we find the best results for the majority of the people when ward lines have been eliminated, and every man is free to act for every portion of the community as he sees best.

Then, my friends, if you come to New Orleans, I want to show you the wonders of a wonderful city. The people of Toronto are doing great things in harbor work, but we are not doing them, we have done them. We, as you know, have the most magnificent harbor in this country, and it belongs to us. We have never parted with our rights. No great railroad corporations, or steamship combinations can take any portion of our river front, it belongs to the people themselves, and there on that great harbor you will see magnificent steel sheds, miles and miles of them, every one of them belonging to the people of the community, whom I represent here today. There you see these great sheds, and the accumulated cargoes for incoming and outgoing vessels at a cheap cost, cheaper cost than any other city can do it, because there is no watered stock. There are no dividends to pay except the service to the people. I speak to you of these things because this is an educational meeting, and I want to know what you are doing and to let you know what we are doing. We thought we had done well in builling these great sheds, but they were of no avail. You couldn't reach them. We found this condition: One or two of the great trunk lines controlled track rights on our river front, and if a merchant had anything consigned to the shipside, and it didn't happen to originate on the railroad lines controlling the track rights, he could not tell when he would get his car. And in addition, there would be a charge of from $8 to $10 a car. So we said that would not do. That may have done at one time, but it wouldn't do now; so the city built its own municipal belt railway. We control it. We connect every public wharf and industry along the river front and we handle the cars of

all railroads and we do it a cost of $2 a car, which is absorbed in the freight rate. (Applause.)

You may talk to me about improving your waterways—it ought to be done, and it should be done. But if you don't take care of your terminal facilities at the harbor you may as well have kept in your pockets the money that you spent in improving your harbor. I want to tell you then that we have done a great work in facilitating commerce. Now, there was a time down there when I wouldn't ask you to come to our city to hold your convention, but we have been putting our house in order. You have heard of the floods, and the great Mississippi. We have built a great levee around our city, in the construction of which not one cent came from the national government, but out of the pockets of our own people. We have built such a levee around that city that we have no longer any fear of floods.

Talk about pestilence; I had the honor to be Mayor in the year 1905, when New Orleans experienced its last visitation of that great scourge, yellow fever. I say last, because we have learned how to care for it since then. We have learned that it can't originate in New Orleans, and if it does come there we know how to take care of it. Let me tell you, my friends, that only about twelve months ago a ship laden with coffee from Rio landed at the quarantine station, 90 miles below the city of New Orleans, on the Mississippi River, with a case of yellow fever on board. Every newspaper in the country chronicled the fact that there was a case of yellow fever in New Orleans. Do you think anybody paid any attention to it? Not a bit. The victim was taken off at quarantine station, put in a screened room, treated scientifically, got well and went back home again. So that is passed. And don't take my word for it, take it from the government, the Census Bureau of the United States: We have the healthiest city in the country today, my friends, the healthiest city; and that is the kind of city we want this convention to come down to.

Let me tell you that I was very much impressed with what the gentleman said here, representing the Chicago Association of Commerce, from an educational point of view. That is what we want the convention to come down there for—to educate my people. That is why I am here, to ask you to come, and we will tell you what we have been doing for education there. I am proud of that word above everything else because there was a time, my friends, when we didn't have the facilities to give the boys and girls the right kind of education. We have made up our minds that

no boys or girls who want an education should be deprived of it for the want of houses to teach them in, or teachers to teach them. Within the last ten years we have built 37 magnificent temples, dedicated to the cause of public education, and we are taking care of our colored population in the same way. We are building schools in which to teach them to do things right, to make them better citizens and thus fitting them for all its responsibilities—making them a help to the government, and to their own people. We really have built some magnificent institutions, and let me say a few words hurriedly about our state.

Do you know, my friends, we have the greatest sulphur producing mines in the world in the great state of Louisiana? We produce more lumber than any state in the Union except the state of Washington. The great salt mines of this country are located in the state of Louisiana, and you know of the sugar and the cotton and the rice. But above all, we have got the best people on earth. (Applause.) There is nowhere, my friends, Chicago not excepted, where people know better how to entertain. That great city is noted for its hospitality, and when you come to New Orleans the Mayor is called upon to give you an address of welcome. And I tell you those are not mere empty words that lift the latchstrings of every house in that community, that open the homes to you, and that make you feel that we are all one great community—one great people. Our friends from Canada I know will like to come there, because they will see so many things in one section down there that will remind them of home. (Laughter.)

We have a great street, Canal Street, that divides the old city from the new. Above Canal Street you will find the live, hustling, bustling city. Below Canal Street, you will find the old quarters—the historic section. You will find in the old quarters conditions that will remind you of scenes in Madrid and scenes in Paris, because we have lived under both flags. We have lived under the flag of France, and under the flag of Spain. And when you come down to New Orleans—to use a slang expression—when it comes to good things to eat we have got them all wiped off the map. (Applause.) I submit myself as an example on that point. We have some famous concoctions there, too, that you have heard people talk about. We, down there, have gotten so accustomed to those things that we don't pay much attention to them ourselves. We have them there for our friends from Chicago. There is just twenty-four hours between Chicago and New Orleans. Our friends come

there from the different sections of the different states of the Union and sample our mint juleps and gin fizzes. That is the only reason we have them there. (Laughter.)

I want you to come down, friends, talking seriously. I want you to come down and inoculate us with your spirit of building good roads. We are, of course, building something along that line ourselves, not as fast though as I would like to see the work progressing, but we are fast improving. We are going to have an amendment to our constitution protecting the rights of the municipalities that tax automobiles, and give that tax to the state. We will then vote a vehicle tax on horsepower, the proceeds of which shall go to the different communities wherein it is levied; and in our community we have proposed a bond issue to build a great highway from New Orleans. You know the trouble with us is that we have a great deal of water surrounding us and there are no in-coming or out-going roads from New Orleans.

We want to capitalize and build 22 miles and two great bridges over the rivers there, which will give us direct communication with the surrounding community. We will then be able to drive in our automobiles to Chicago and New York, which we now are unable to do; but I feel that if a convention of this kind comes to New Orleans and inoculates us with that spirit of building, we will have roads going out all over the country.

I do not like to trespass upon your time any further, but I want you to come to New Orleans. I beg of you to hold your next convention in New Orleans. You can do a great deal of good. I read the objects of your association, and the greatest field for you is down South in Dixie, to work down there, to spread the gospel that you speak of as the object of your association—to spread the gospel of building good roads. The greatest field for that kind of work today is down there in the very heart of Dixie where I come from, New Orleans, and I beg of you to come to New Orleans in 1915.

I thank you very much. (Applause.)

PRESIDENT McLEAN: Gentlemen, I am sure you will all be happy to go to New Orleans. We will now have the pleasure of listening to Colonel Sohier, who is well known to all of you. (Applause.)

Address by William D. Sohier:

Chairman, Massachusetts Highway Commission

In this third greatest city of the world, 50,000 years after the Babylonians went over and improved the road, they tell us that there are 1,000 miles of road that the Babylonians could not have gone over, and 3,000 years after the Israelites went down over the Red Sea on a hard road, they tell us that there are 16,000 miles in Illinois that are not improved, and that a chauffeur cannot go through without swearing. (Laughter.)

Now, we are all delightel to be here. I know I express the views of every member of the road congress when I say that we are not surprised, though somewhat dismayed, at the oratory which has been poured upon us. Very few of us poor road builders, who have to talk about building roads, can make a speech; very few of us can be heard. And whenever we come to a strange community they select a triumvirate, as they did here, to make oratorical speeches, that if we only would come to their state we could get the money we want.

Now, gentlemen, really there is very little for me to say. From this opening session we have found that we are lucky if we live in the United States; we have found that Canada is so large that it absorbs most of us; that New Orleans is so improved that there is room for all the harbors in the world to get inside, and Illinois is the largest or second largest state in the United States of America. And I am wondering if there isn't room for the state of Massachusetts in the lake. We would like to get somewhere, and we have had all this talk, and it seems to me that it is about time that the road builders began to say a little something about building roads. They are getting all this money in Illinois, and I quite agree with the gentleman that the one thing they need in Illionis is roads. Anybody will agree who has been over any of the roads that the one thing they need in their roads is drainage, but they won't get drainage if they don't have some systematic way of spending the millions of dollars, the $160,000,000, that they are going to raise. They won't get their roads properly located if they don't lay out a proper scheme or the proper location, and they won't get the proper drainage.

They won't get the proper drainage if they change their engineers every year, as they have done in the state of New York—five times in the last eight years. There is no chance for anybody to know how his predecessor meant

to spend the money, no chance for anybody to find out what his job is before he is removed. I might repeat the speech I made in Rochester, N. Y., about six years ago, when they had had only two changes and had spent about $35,000,000. You can't have good roads if you don't have good road builders. You can't have good road builders if you don't take the men that have spent their lives in building roads and who know something about materials, grading, drainage, and the various things that go together to make good roads. These men spend their lives in building up their knowledge. They sometimes spend a part of the public money in giving them that education, and the next minute they are turned out on account of politics—nothing but politics. A man is a Republican or a Democrat in politics, but not in road building. Any man that has served his country and his state well in road building, who has got his education at the expense, more or less, of the state, is an asset to the state and he should be recognized as such an asset.

Now, in Massachusetts we haven't had a change, and when I was with Mr. Carlisle in New York the other day he remarked that Massachusetts was the only state in the United States that hadn't had politics in its road building. Now he may be right or he may be wrong. Some of you other fellows can stand up and disclaim that if you like. I know that any results that we have attained have been due to the engineering force in our office, the continuity in the commission that was directed in engaging that engineering force, and to the force of public opinion. I am just going to tell you gentlemen those things that have happened to us, because I think we might help you. You have got the most tremendous road movement—road boosters. And it is general all over the United States. The states are appropriating money faster than you can spend it economically and well, because you can't get the men who know how to spend it. They don't exist in the numbers that you are trying to get everywhere. Every week some new township, county or state appropriates a million dollars or five hundred thousand dollars or one hundred million dollars, and it is absolutely impossible to find road men ready made. They have got to be made. They have got to get their education. The road engineers do not exist in sufficient numbers to give you what you ought to have. You have got to build them up. Any results we have gotten in Massachusetts have come because we have built them up.

I would like to say to a few of you gentlemen that I

think you will experience very much the same difficulties that actually happened to us. Hostile movements were started in communities—started in the farming communities. They did not approve of a state highway commission; did not approve of state roads. Twenty-two years ago the commission started its work in building state roads and in some of the communities it took five or six or seven years before there was a demand for state highways. Public opinion had to be built up in the state of Massachusetts. It was built up by the fact that we had built a better road than the local communities. The road didn't need any argument; it spoke for itself. That is what you gentlemen have got to do. You put a road on the map and if it is a good road everybody who goes over it will see that it is, and they will immediately say, "that is a state highway." Anybody going through Massachusetts will tell you where the state highways are. They follow the white guard rails because they think that is the state highway. Sometimes it is, and sometimes it is not. It is sometimes state aid. That road speaks for itself, and is an object lesson and it behooves you to spend your money to the best advantage to the end that people cannot say you have spent so much money on a road, and look at it—it is not good for anything.

Now, I am going to say one more word only. We have a state aid law, and the change of sentiment in our state is so great that in the last five years the municipalities in the state of Massachusetts put up more money to be spent by us than the whole appropriation made by the state five years before for the construction of highways. Actually more dollars were put up by the local communities than the state had been spending for construction in state aid and maintenance put together five years before. We are improving more miles of road with the town money under our engineering advice in the towns than we were building in the state of Massachusetts. The reason for that is on the state aid roads we usually built gravel roads, and they are somewhat less expensive, so that the same amount of dollars is building more miles of road because we can build them cheaper.

Let me say one word more: We are all borrowing money. It requires large sums of money and the roads are not going to last as long as some of the bonds. After your roads have gone you will still have the bonds and the sinking fund to pay unless you make some provision for maintaining those roads. Now, I think our experience there may be worth something to you. Starting twenty-two years

ago the State Highway Commission began to build state highways; it has built about the same number of miles every year. It has about a thousand miles of road now, nearly eleven hundred. We borrowed money originally on thirty years' time. Our roads, you see, average eleven years old, and there is not one single piece of state highway in the state of Massachusetts today that isn't standing up and taking the traffic that goes over it a good deal better than most of the streets in the city of Boston are taking their traffic. There are one or two that are a little rough, but in the main you can start at one end of our state and you can go to the other on a good stretch of highway that hasn't got any holes in it. Our highways cost us about $12,000,000 including what the towns put in to help—$10,000,000 for the state. The counties, under our law, gave back 25 per cent. The consequence is our expenditure is somewhere in the neighborhood of $8,500,000 to $9,000,000. We had a sinking fund provision and that sinking fund has reduced our net debt today to $6,000,000.

Now, this is what I want you gentlemen to mark: We managed at the psychological moment—when the roads had got so old that they had to be resurfaced—to get enough money to pay for resurfacing them, with the result that of over 600 miles of road that is about eight years old more than half has actually been resurfaced, not only resurfaced with bituminous macadam top, but widened 3 ft., from 15 to 18 ft. And as we stand today we have got an asset in the state of Massachusetts with a net debt of $6,000,000, and you could not replace the original for $12.000,000.

Now, there is the answer to your bond issue, if you are going to issue bonds. If you do get enough for maintenance, if you do get enough money and expend it properly to resurface your road from time to time, so the bottom surface is never worn out, and the road is always as good at least as the original road until the maturity of the bonds, you are making your descendants bankrupt. We are borrowing money for only fifteen years now, and you needn't be afraid of your bond issue, if you adequately maintain your roads. But if you are going to issue bonds, don't do as I think New Jersey did, don't build the roads and then place the maintenance of them on the county. The consequence there was that the roads were neglected, and they are having hard work today to get money to resurface a great many miles of the macadam roads that are absolutely worn out because they are ten years old and nothing has been done to them to keep them in repair. If you are going

to build roads, gentlemen, and borrow the money, make some provision for adequate maintenance, and my belief is that there should be some state authority to control the maintenance, and not leave it to the local authority. Authorize the state to keep the roads in repair so that at the end of the time which your bonds run, your roads are worth what they cost, and in that way you will have done a great work for the United States of America. If you borrow money and build roads and don't take care of them, your roads in ten years will become all worn-out, and your bonds will have ten years to run and that will be doing the worst thing that can be done for the good roads movement in the United States of America. I think that every one of our road builders in this room will do his best, but the other people, the people that appropriate the money, have got to be educated to find out that when they build a road, it is not going to last forever. A road is going to be worn out according to what it has to carry, and if it has got to carry much traffic—heavy traffic on narrow tires—it is going to be worn out very quickly. It costs a cent a vehicle a mile to maintain your roads. That means that some light vehicles may only cost a third of a cent a mile, and the heavier vehicles may cost you three cents a mile for the maintenance of a road like a macadam or a gravel road. Your whole problem is whether you want to build more expensive roads, or can afford to, that can take that traffic more cheaply than that and still pay for the additional interest cost. That is the problem that is up to the road builders. I hope none of you will be discouraged by the gentlemen who have gone ahead, because we all know we can't talk much, but that you will all come and help this convention and tell the people that come here how they can help themselves, and I know you all can do it.

I thank you very much, Mr. President. (Applause.)

PRESIDENT McLEAN: I am sure that you all appreciate very much the remarks of Colonel Sohier. The financing of road construction on this continent is a problem which must be handled very seriously and earnestly.

Now, just before we retire, let me announce the Committee on Resolutions: Mr. N. P. Lewis, Chairman, and Messrs. Sargent, Crosby, Dean, Hirst, Pratt, T. H. MacDonald, James H. McDonald, Foster, of Pennsylvania. Mr. Lewis has asked that the Committee on Standards meet in Room 808 at the Hotel La Salle at six o'clock this evening. I wish to explain the program for this evening as there seems to be some mis-

understanding. The City of Chicago is tendering a public dinner at 6:30, to which you are invited. The tickets are $2.50 each. Following this at eight o'clock there will be a public meeting in the Hotel La Salle, where you will hear some good speeches. Now, don't mistake the dinner this evening for the annual association affair, which will also be held in the Hotel La Salle tomorrow evening at half past six. The tickets for that are $3.00 a plate, and I sincerely hope that you will all be there, as we promise you a pleasant time.

The session tomorrow will open at ten o'clock, and the exact place of holding it will be announced at the exhibition before the time for meeting.

I thank you for your courtesy and attendance this afternoon.

EVENING SESSION

On Tuesday evening a meeting was held at the Hotel La Salle, following a dinner arranged by the local road and street officials and road organizations. William G. Edens, President of the Associated Roads Organizations of Chicago and Cook County, presided, and introduced as speakers Mayor Carter H. Harrison, of Chicago; Mayor H. C. Hocken, of Toronto, Ont.; Mayor Winn Powers, of St. Paul, Minn.; W. A. McLean, President of the American Road Builders' Association; Nelson P. Lewis, Chief Engineer of the Board of Estimate and Apportionment, New York, N. Y.; Richard J. Finnegan, Secretary of the Illinois Highway Improvement Association, and City Editor of the "Chicago Evening Journal;" Frank Terrace, of Portland, Ore., a delegate from the States of Oregon and Washington; A. D. Gash, President of the Illinois Highway Commission, and James H. MacDonald, former State Highway Commissioner of Connecticut. About five hundred were present at the meeting.

In introducing Mayor Harrison, Mr. Edens spoke of the cooperation of the officials of Chicago in making the affair of the week a success, and mentioned the construction done on Sheridan Road, an up-to-date boulevard connecting Chicago and Milwaukee, Wis. He told of the plan of the Illinois commission for 20,000 miles of state aid road in the state. He stated that during Mayor Harrison's administration more had been done for the improvement of city streets than had been done under any mayor in the history of Chicago.

Mayor Harrison began his remarks by stating that for many years he had been an advocate of good roads. He said that he was an enthusiastic bicyclist twenty years ago and was a member of the League of American Wheelmen and other clubs. He told

of riding 5,000 miles on his machine in 1896, and stated that this experience had taught him the value of good roads. When he was a delegate to his party convention at Peoria in 1897, he was influenced to offer for incorporation in the party's state platfrom a plank for good roads. "But," he added, "I was nearly mobbed for it by some of the down state democrats." He told of opposition to good roads while he has been mayor beginning in 1897 —"when I first began to run for mayor of Chicago." At that time he and Commissioner of Public Works McGann decided against the further use of cedar block for pavement in the city. This aroused opposition, but he stood for good pavement, he said, and later some of his earlier opponents came to him and thanked him for the stand he had taken. Now the city has, he declared, a road building plant entirely sufficient for the present demands. It collects $800,000 wheel tax annually and uses it in the construction of improved streets.

"Toronto," said Mayor Hocken, "has recognized the value of good roads more than any other Canadian city. The city has come to realize that macadam is not good enough paving for heavily traveled streets, though for a long time we did not diagnose our troubles rightly. We now have a plan for road building that includes an international highway from Toronto to New York and later to Windsor and Chicago. We are building a 40-mile stretch of road now out of the city, and of this cost the city is paying 25 per cent, or $150,000. The need of good roads is as imperative for the farmers as for the city residents, though the former do not seem to realize it. The state, too, has a responsibility in this matter, and it is realized in Ontario. Our provincial government there now pays one-third of the cost of road building in the province. Several million dollars was asked for from the federal government, but the senate of our government refused to pass the appropriation and it fell through. However, it shows we are working in the right direction. In closing I want to mention the working people of Toronto, who are doing more than any other class of citizens in caring for the city streets."

Mayor Hocken closed with an appeal to meet the question of unemployment by good roads work, and to see to it that the good roads laborers secured employment during the months of the year when road work is impossible on account of weather conditions.

Mayor Powers told of the commission form of government which is in operation in St. Paul, and stated that he, with some other of the commissioners, was in Chicago to learn of proper good roads work from the meetings of the congress. He told of the construction of 25 miles of paving last year and plans for 30 miles this year. He stated that St. Paul was developing

a policy of improving all roads running into the city, whether they are within the limits of Mercer County or not. He ended with a reference to the resources of Minnesota, "the Bread and Butter State," mentioning its wealth of iron.

At this point Mr. Edens presented to Mayor Harrison the spade with which the final work was done on the first piece of state aid road opened in Illinois. This event took place during the week of Dec. 12, 1914, at Blue Island, a suburb of Chicago. Mayor Harrison in accepting remarked that the spade would be used in digging up additional funds for good roads.

W. A. McLean, President of the Road Builders' Association, was next called upon and spoke briefly of his satisfaction in the work for good roads which was increasing throughout the country.

Nelson P. Lewis, Chief Engineer of the Board of Estimate and Apportionment of New York, N. Y., spoke next, devoting his remarks largely to the American Road Builders' Association, outlining what the organization stands for.

Address by Nelson P. Lewis.

Chief Engineer of the Board of Estimate and Apportionment, New York, N. Y.

The American Road Builders' Association stands primarily for the technique of road building. This includes the rational designing of a system of roads or streets for urban districts, for the connection of small centers of population with the great cities and with each other, for the articulation of these roads with those of the next larger unit—the county, for the articulation, in turn, of the roads of one county with those of adjoining counties, making thereby a real system of state roads, and finally for such intelligent cooperation between the states, with the aid and service of a federal bureau of roads, as will result in a system of national highways—not a system built and maintained at the expense of the national government, but a system so intelligently planned and so standardized with the aid of a federal bureau that passage from one state to another will not be evidenced by an obvious improvement or deterioration of the road surface, or by the neat or slovenly aspect of the roadside. Such a system should be determined by the actual needs and the best interests of all the people, and not by the selfish desires of those who happen to live or own property on the line of any particular road, or by the ambition of a state, county or municipal officer, or of a Warwick or uncrowned king, sometimes called a "boss," who is supposed to make or unmake such officers.

The technique of road building, of course, includes a careful study of the availability of local material for road construction; when it is more economical to use a shorter lived material of low first cost, but which will require frequent renewal, and when conditions are such as to warrant the importation of the best and most durable material that may be secured, even though the cost be considerably greater. To spend $15,000 or $20,000 per mile on a road which will be used by fifty or one hundred vehicles a day is poor business. It is almost as bad business to limit the cost of a road which will accommodate 5,000 vehicles a day to $5,000 a mile, because there is some cheap local material which will build a road that will last a few months under such traffic.

The American Road Builders' Association also stands for sane methods of financing highway improvements. It deplores the tendency to incur enormous debts for long terms of years for the purpose of building roads that will last but one-tenth of the period for which bonds are issued. It believes that any scheme for road improvement should include a definite program for the upkeep and surface renewal of the roads as well as their original construction, and that the responsible officials and the general public as well should have a pretty clear idea as to how much it is all going to cost, how the money is to be raised, and, if a debt is to be incurred, how and when it is going to be liquidated, and whether there will be anything left of the roads after they are paid for.

The Association also stands for an organization that will be permitted to handle a business and highly technical problem, such as the planning, construction and upkeep of a great road system without constant political interference. It is unable to see the relation between this problem and those of tariff reform, the regulation of the trusts, the political status of the Philippines or the policy of this country towards the rival factions in Mexico or the several countries engaged in the great European war. We believe first in the adoption of a sane constructive program and then in a continuity of policy and purpose in carrying it out. We favor the creation of administrative units of sufficient size to permit effective organization without excessive overhead charges. Some of the greatest obstacles to efficiency in highway work are too small local units, lack of expert service and the firm conviction on the part of almost every citizen that he is as competent to build and care for a road as he is to sit in Congress or to fulfill the duties of a cabinet minister.

We do not consider that it is necessary for us to engage in a propaganda to arouse interest in road improvement. There are other organizations which are doing that, and doing it effectively. The automobile maker and owner will see to it that interest in

the question does not die. Our purpose is to see that this interest, once aroused, is guided along rational lines, and that the improvements which are made are planned in a rational fashion, and that the work is sanely financed, skilfully and honestly done, and efficiently and economically maintained.

R. J. Finnegan told of wasteful efforts to maintain Illinois roads and of the "throwing of thousands of dollars into the mudholes of Illinois during past years." He mentioned the organization of which he is secretary and stated its problem as being one of dirt roads. "If this congress," he said, "can present some method by which these roads can be improved and maintained, it will have performed a great mission."

Frank Terrace, of Washington and Oregon, praised the resources of those states and called attention to the great work for good roads which had been done there in two years. "Two years ago," he said, "there was not a piece of improved highway in either of them. In two years, however, more than $3,000,000 has been spent in road building." He referred to the scenic highway along the Columbia River, which he prophesied would be the greatest of the kind in the world. He pronounced good roads a matter of patriotism.

A. D. Gash, President of the State Highway Commission, appointed by Gov. Dunne, of Illinois, gave some interesting figures regarding work in that state. He said that when the plan of the commission is completed there will be 16,000 miles of first-class roads, which will cost about $180,000,000. At this rate, he estimated that the per capita cost of the roads to the residents of the state would be about $30. Farmers are paying, he said, at the rate of 8 cts. per acre per year for twenty years, or a total of $1.60 per acre. This he declared would be more than offset by the increased value of their land when the work was done.

James H. MacDonald spoke briefly, and praised the support given him in his efforts for good roads in Connecticut by the League of American Wheelmen. He said that now automobiles have come and farmers are realizing the value of good roads the movement for them will go on to a successful conclusion.

Wednesday, December 16

SECOND SESSION, 10:30 A. M.

CHAIRMAN A. W. DEAN: The President could not be here this forenoon and asked me to preside in his place. I will not take up any of your time with preliminary remarks.

The first paper on the program is entitled "Road and Pavement Dimensions—Widths, Depths and Crown" by Mr. Linn

White, Chief Engineer of the Board of South Park Commissioners of Chicago, whom you all have heard before, possibly, and who can handle this subject with the greatest of knowledge. (Applause.)

Road and Pavement Dimensions—Widths, Depths and Crown

By LINN WHITE
Chief Engineer of the Board of South Park Commissioners, Chicago, Ill.

The dimensions of roads and pavements—width, depth and crown—are, to an extent at least, capable of analysis and scientific determination. Yet a consideration of practice in these respects indicates that pavement dimensions are generally fixed by precedent, experience or arbitrarily established rule.

It is hardly true that the construction of every road or the paving of every street is an original problem in itself requiring the collection of data and the independent determination of dimensions. Some standards must be adopted and rules formulated that are somewhat arbitrary and empirical, for the sake of uniformity, if for no other reason. But, in spite of this necessity, the design of a road—width, depth and crown, as well as longitudinal grades and character of wearing surface—should be adapted to the traffic, soil, climate, drainage, etc., of the particular locality in which it is situated.

It will, therefore, not be attempted in the brief discussion of the subject within the limits of this paper to formulate definite rules as to proper dimensions of roads and pavements, nor even to tabulate examples of practice that may be considered good or bad, but to point out certain more or less evident principles governing their design with the expectation that in the discussion that may follow examples of practice will be brought out.

In response to inquiries recently made for data pertaining to this subject and for the purposes of this paper, two of the replies received are illustrative of extremes of practice with regard to the establishment of hard and fast rules—especially as to *crown* of pavements. One from one of the largest cities in the United States where within the last few years very radical and decided advances have been made towards an efficient administration, states "an old ordinance (still in force) introduced by the Survey Bureau makes the crown the same for all classes of city pavements." There may be a sound reason for stating in a local improvement ordinance the crown of the street but why should a general ordinance passed years ago fix the crown of all pavements at one figure through all the varying conditions of traffic and advances in the art

of paving? Another reply received from a state highway commission which has long been considered an example and teacher for other highway commissions, says it has no "hard and fast" rules of practice as to depths and crowns of pavements.

Here are two examples of exactly opposite extremes of policy, and the facts are, the latter mentioned highway commission has certainly lost nothing in quality and reputation of work by leaving the questions of depth and crown of roadway pavements to its engineers where such questions belong.

Widths of roadways are governed primarily by the extent and character of traffic. A highway may be designed for the passage of only two vehicles with no provision for standing next the curb, in which case the paved width can scarcely be less than 16 ft. As the importance of the highway increases and vehicles at higher speed use it and more provision for standing room, foot passengers, etc., must be made, the width should increase to 18, 20 or 24 ft. A street is generally paved to a greater width because of the necessity of standing space in front of the more closely spaced residences and stores. Twenty feet between curbs may be considered a narrow street, especially in our newer towns and cities of the West. In the older communities and older towns the narrowest streets are to be found but they are not examples to be followed. As instances of narrow streets in our own country and time note the older portions of Boston, St. Augustine and Havana. In a recent publication descriptive of one of the remarkable royal cities of an earlier civilization it is stated the average breadth of the main streets was less than two meters.

The necessity of light and air between the bordering rows of buildings, proper proportion to heights of buildings, the desirability of trees, parkways, and other beautifying features, are reasons for additional width in streets which generally do not apply to roads or highways, though in these relations the width to be considered is between extreme lines rather than the paved width.

In a comparison between the paved width of streets and roads note should be taken of the fact that in streets the whole width including gutters is uniformly paved and used by the traffic, whereas in speaking of the paved width of a road as, say, 18 ft., the earth shoulders and gutters are not included—an additional width on each side of perhaps 5 ft., bringing the total width of such a road up to 28 ft. As an instance of the difference that may properly be made in the width of a street because of stopping and standing vehicles

next the curb the following instance may be cited. One of the principal business thoroughfares leading out from the central portion of Chicago borders public park territory for more than a mile. A double track electric car line was on the street and on the side next the park the pavement was made 12 ft. wide from rail to curb, while on the opposite side where the property was devoted principally to business purposes the width was 18 ft.

Manifestly the strongest argument for keeping the width of pavements down to a minimum is that of cost, both of construction and maintenance, where the total width between property lines is not cramped. However, for certain reasons mentioned above, mainly esthetic, applying especially to residence streets, boulevards and highways, the pavement should not occupy the whole width.

The boundary lines of roads and streets are often encroached on by owners of abutting property and the actual width reduced by projecting steps, entrances, pilasters of buildings, etc. The laxity of supervision that permits such appropriation of public property to private uses cannot be too severely condemned. An encroachment once permitted is difficult to remove, and as time goes on is more and more objectionable. Encroachment on the public highway should be as vigorously guarded against as on private property. In the design of pavements sometimes features of construction are introduced that reduce the effective width, such as badly designed catchbasin inlets, excessive cross slopes near the gutters, raised crossings and approaches to intersecting sidewalks, etc. There is nothing logical in a design that calls for a catchbasin inlet at the corner of intersecting streets with deep gutters and high curbs, and then, as a means of overcoming these unpleasant features, a raised crossing approach that forces traffic out towards the center just where congestion is the greatest.

In the improvement of country and suburban highways more latitude may be taken as to dimensions and character of pavement than on city streets. Conditions are generally more varied. Location, grades, drainage, foundation, materials of construction, require more individual study and collection of data. It must be remembered the kind and quantity of traffic in any district—the population and industries—change and develop with the construction of roads. A good road is the most potent factor in the upbuilding of a community and it should be constructed to carry not only the existing traffic but the increase that will be stimulated by the construction of the road itself.

Correct relation between the service demanded of a road

and the elements of design, which include carrying capacity and durability, is essential in the construction of any good road. The proper depth or thickness of pavement is a large factor in determining the capacity and durability. Under modern conditions we can not get away from constant maintenance if we are to have satisfactory roads and streets. Therefore it is impracticable to construct so liberally and permanently as to entirely resist wear. The Romans achieved this to a considerable degree in their roads which were several feet thick built of layers of stone blocks. So their principal roads, or some remnants of them, exist today but do not meet any of the needs of today. They did not know, apparently, much of the art of subsurface drainage or preparation of the roadbed to receive the stone, and while it is possible they may have crowned the surface to take away the surface water, there is little doubt but their roads were rough, dusty, non-resilient and generally unsatisfactory according to modern standards. Certainly they would be now, and were then, expensive to construct. At that period there were but few roads, only between important points and principally for military purposes. Now the demand is for roads everywhere built as economically and as efficiently as possible. The thickness, no matter of what material constructed, should be the minimum compatible with intelligent planning. With all the foresight that can be exercised a road good for this decade will not be good enough for the next decade, all of which is but saying a large part of the road problem is a maintenance problem.

An efficient thickness of pavement involves all other elements of economical construction—proper underdrainage, compaction of subgrade, crowning and waterproofing of surface, etc.

With all the kinds of wearing surfaces that have been devised—stone block, brick, creosoted wood, asphalt and tar compositions, oiled and water bound macadam, and the infinite variations thereof—there are only two recognized materials for foundations—concrete and macadam. The main difference in the action of the two is that concrete is a practically homogeneous material, the particles positively bonded and knit together so there is a beam or slab action carrying the wheel load over a comparatively broad expanse of base, while macadam is made up of separate particles which are inter-supporting only and transmit the load from one particle to the others beneath. As one particle of stone in the surface may be supported on two, three or four particles immediately below, and each of them on an equal number in the next lower layer, and so on down to the earth beneath, we may reason-

ably estimate the wheel load is spread to the earth base at an angle of approximately 45 degrees in all directions. Thus if the contact surface of a wheel is 4 by 6 ins., and the load on each wheel 2,000 lbs., it will be spread over approximately 2 sq. ft. of supporting earth. If the supporting power of the earth is 1,000 lbs. per sq. ft. (authorities give from 500 to 2,500 lbs. per sq. ft., according to character of earth, effectiveness of drainage, etc.) we may conclude our macadam foundation is thick enough to carry the load.

A concrete foundation will obviously spread the load to a greater extent than macadam on account of its homogeneity and consequent slab action, and may be made correspondingly thinner. Calculation of the thickness of a concrete foundation, however, would be fruitless as the breaking strength of a 5 or 6-in. slab of concrete made as such concrete usually is cannot be very high. Cracks occur in concrete foundations on account of contraction, settlement, etc., which destroy the slab action. There is another reason why concrete pavement foundations can safely be made thinner than macadam, and that is the greater stability of the mass or resistance to lateral displacement.

If there is a wearing surface of blocks, asphalt composition, or other material, on top of the concrete or macadam foundation it will further assist in the spread of the load. The transmission of the load to the foundation through a wearing surface of blocks can only be safely calculated in vertical lines with a surface contact the size of the block, on account of the vertical joints between blocks.

The thickness of the various types of wearing surface is mainly governed by practical reasons. It is not by any means true that pavement surfaces generally are to be improved by arbitrarily increasing their thickness. Two inches is probably the practical and economical thickness for asphalt and asphaltic concrete wearing surfaces because before the two inches is worn away the inequality of surface becomes a serious objection and a greater thickness would allow it to roll and shift when softened by hot weather. Creosoted wood blocks cannot be made less than 3½ or 4 ins. thick because the blocks would split too easily.

The crown of a pavement is a matter almost entirely of surface drainage. Even though a road or street has a considerable longitudinal grade it is necessary to carry the surface water to the gutters. The crown probably assists somewhat in keeping the central portion of the street clean as dust and dirt is more easily swept to the gutters by rain, winds and passing traffic.

As far as the use of a pavement is concerned it would be more desirable to have it level in cross section, and under certain conditions safer. A vehicle turning on the outward sloping crown of a road is pitched in the wrong direction and if the pavement is slippery tends to slip or skid. The outer rail of a railroad is raised on curves to assist in turning the curve and the better to resist centrifugal force. On a street pavement the inner rail, so to speak, is raised, and, according to any method of construction yet developed, necessarily so. The problem is to reduce the crown as much as practicable and establish reasonable rules for distributing the pitch fairly evenly across the width of roadway. The character of wearing surface has much to do with the amount of crown permissible.

The following list of pavement surfaces is arranged in the order of amount of allowable crown:

Water bound macadam.
Oiled and tarred macadam (surface treated).
Stone blocks.
Brick.
Bituminous concrete (mixed before laying).
Sheet asphalt.
Creosoted wood blocks.
Portland cement concrete.

In this list creosoted wood block is put near the bottom because it is a slippery pavement surface and needs a flat crown. Also by reason of the true surfaces and gauged size of blocks it can be laid close to a theoretical grade. Portland cement concrete is put at the bottom of the list, not because it is slippery, but because on account of construction methods it can be screeded or struck to a fairly exact grade, whereas other plastic pavements, bituminous concrete and sheet asphalt, cannot be made so exact on account of the necessity of rolling after spreading to secure compression.

If the longitudinal grade of the pavement is practically level the crown must be greater at catchbasin inlets than at gutter summits between inlets unless the grade of center of roadway is carried up and down with gutter grades, which is not a desirable method. On streets with longitudinal grades requiring water in gutters to flow all in one direction and on country highways where drainage is carried away by surface ditches, the crown may be made the same at all points.

The cross section of a pavement may be a segment of a circle, parabola, or two inclined planes connected with a segment of curve. Either of the two latter forms is preferable to the first because a segment of a circle makes the pavement

fairly flat in the center and grows unpleasantly steeper near the gutters. The inclined planes or parabola "get away" on a quicker slope from the center and do not so materially increase as the gutters are approached. Traffic then will use all parts of the pavement with fairly equal facility and ease. In the case of roadways with surface car tracks in the center the cross section adopted should provide sure and positive drainage away from the rails, and a simple inclined plane from the rail to the gutter is probably the best.

Whatever theoretical crown or cross section is adopted it should be remembered that in actual construction the cross section will be only approximated. It is not practical to set enough grade points or to maintain them carefully enough to attain the theoretical section.

In practice, in setting grades for crown or cross section, it is common to adopt a rule of measuring say one half the distance from the center and dropping one-fourth the total crown. This will give a segment of an all curve cross section. Another rule may be to measure two-fifths the distance from the center, drop one-fourth of crown and thence straight to the gutter. Other modifications of such simple rules may be devised using three points on wide roadways between center and gutter, approximating more closely to a true parabola or providing longer inclined planes and a shorter connecting curve. It is sometimes advised to increase the crown on pavements having considerable longitudinal grades, thus carrying the water more quickly to the gutters. The opposite practice is generally better—to decrease the crown on steeper grades. There are two reasons for this—the tendency to slip or skid is less and the washing or cutting action of water is less than on the increased crown section.

CHAIRMAN DEAN: Gentlemen, we will now listen to a discussion on Mr. White's paper by Mr. A. R. Hirst, State Highway Engineer of Wisconsin.

A. R. HIRST (State Highway Engineer of Wisconsin): Mr. Chairman, and Gentlemen: I did not have the pleasure of seeing Mr. White's paper before appearing here, and due to various complications I did not have the pleasure of hearing some of it, so that I think the only contribution I can make of value is possibly to state the practice in Wisconsin as to width, depths and crown.

We build a very large mileage of very low-class country road. Our construction is narrow. We have adopted for single track road a 9-ft. width and endeavored to obtain on this 9-ft. width a crown of at least 4 ins., very slightly less

than 1 in. to the foot. I know that we differ from practically every state in building such a high crown and while these crowns may seem excessive when the roads are newly constructed there is no remarkable excess after one or two years. I seriously doubt whether with a 9-ft. road it is possible to make the crown too high with the ordinary machinery available, and it is inevitable that the crown is never going to get larger and is certainly going to get less with wear. We build most of our roads—and I think it is common in most states—immediately after the rough grading is completed. I believe some settlement of the fills is inevitable, and this settlement becomes evident in the crown of macadam roads after a year or two.

With the closer following up of construction with surface maintenance in the case of water bound macadams and gravels, I believe it will be possible for us to slightly decrease the crown. There can be no doubt that the less crown we can build and shed the water to the ditches the better for the road surface, as the less crown the more encouragement there is for the traffic to get away from the center of the road. We have established, in our own minds—we haven't been able to convince any one else however, of the correctness of the principle—that the only thing that will drive the traffic on an ordinary crowned road from the center of that road is more traffic. In other words, irrespective of the width of the sufacing or its crown, wheel traffic of all descriptions will follow the center of the road and make a rut there no matter what the width.

If you have a pavement on which the travel is so large that this traffic will be distributed you must of course build a two-track highway. In Maryland in the old days we considered a 12-ft. road a double-track highway. In Wisconsin we adopted a 14-ft. standard. We changed this year to a 15-ft. standard for a double-track highway, and I am not at all sure that next year we will not move up to an 18-ft. standard, especially on those roads which we believe we are constructing for a long period of years, such as concrete and vitrified brick.

I believe that a mistake is being made by any state which constructs roads which are going to be available for through traffic if they build them less than 18 ft. wide. Our experience has been that if you do not provide an ample double track you had better provide only a single track because the 12, 13 or 14 ft. widths are simply invitations to disaster. The automobile drivers think they can pass at 40 or 50 miles an hour and sometimes they think wrong. The 9-ft. roads which

we have built have caused very few accidents because drivers know that they must slow down when they pass another machine, while in the 12 and 13-ft. roads they think they can pass and they stay on the surfaced portion. We have built nothing wider than 18-ft. except one road in the neighborhood of Milwaukee which we built 40 ft. wide for reasons other than accommodating the traffic.

As to the depth, most of our roads, both of gravel and macadam, have a finished depth of about 7 ins. The depth is the same at the center as at the edge. We put no crown on our macadam and gravel roads with material. In other words, the subgrade is the same shape as the finished surface.

A practice which possibly we may adopt—I am trying to get my nerve up to the point of adopting it—is to build the second course of our macadam and gravel roads wider than the first course. Those familiar with traffic conditions know that on the average country road about 9 or 10 ft. carries at least 90 per cent. of the vehicle traffic; that outside of those limits there is simply an occasional passing and getting off of possibly one wheel—in most cases the light wheel. It seems entirely possible that the construction of a first course of 9 or 10 ft. of ample macadam thickness with an extension each side of a second course 2 or 3 ft. beyond that point is entirely logical. We find something of that effect in the construction of some of our macadam roads. The cases in which the shoulders of roads will hold up when even small amounts of screenings go off on the shoulder, maybe a fraction of an inch or so, are surprisingly many. I think we are coming in Wisconsin to the point where, when the 9-ft. width is not ample, and where there is quite frequent passing of vehicles, but most of the passing vehicles are light, we will wing out the courses, building a 9-ft first course and making the top course 15 or 16 or even 18 feet wide, and get a road giving an effective width of 15 or 16 ft. with less materials than you would a full depth 12 or 13-ft. macadam, and I believe it would be just as efficient.

We never build a macadam or gravel road with a thickness of more than 8 ins. If 8 ins. of finished macadam or gravel will not stand up under the traffic it is a sign that the road is not properly drained and the additional material won't help matters.

As to concrete, we built this year in the neighborhood of 50 miles of concrete. We adopted a uniform standard on all soils of 8 ins. in the center and 6 ins. at the side for roads of 15 to 18 ft., the crowns varying slightly. On the nar-

rower roads the crown was ¼ in. per foot, the side depth being 6 ins. and the center depth varying with the width. We have experimented somewhat in Wisconsin with 9-ft. concrete roads with gravel or stone shoulders. I believe we have something like seven miles of that type, and while these gravel and macadam shoulders amply serve the purpose and keep traffic out of the mud, I am not convinced that an earth shoulder, where the nature of the soil is good, does not offer better facilities for turning out for the greater portion of the year. It is impossible to roll these gravel or stone shoulders without danger to the concrete. A loose surface is the result (at least for some time) and if an automobile turns out into this loose surface at a speed of 30 or 40 miles an hour, it is dangerous. The earth surfaces are less dangerous.

On our wider macadam roads, 15 to 18 ft., we are setting them for a crown of ¾ in. per ft. with the idea that after they are finished we will get a crown a little greater than ½ in. per foot. If you want to get macadam crowned to the height shown on the plans where the subgrade is parallel with it, you have to crown your subgrade considerably more than the expected finished crown of your macadam. I thank you, gentlemen. (Applause.)

CHAIRMAN DEAN: The next gentleman to discuss this paper is Mr. H. R. Carter, State Highway Commissioner of Arkansas. Is Mr. Carter present? Mr. Carter is not present and I understand there is no written discussion.

The next gentleman is Mr. S. D. Foster, Chief Engineer of the Pennsylvania State Highway Department. Is Mr. Foster present? Mr. Foster is not present.

The next gentleman is one of the originators of the American Road Builders' Association and its first president, Mr. James H. MacDonald. (Applause.)

JAMES H. MACDONALD (former State Highway Commissioner of Connecticut): Mr. President and Fellow Delegates: I find myself about in the same position that Brother Hirst did in reference to having access to Mr. White's paper, and I feel a good deal as did the minister who apologized to his congregation on Sunday morning, saying that he had been very busy through the week and hadn't had a chance to prepare his sermon so they would have to take what the Lord sent them, but that the next Sabbath he expected to do better. (Laughter.)

I think that the only thing we can do with this great question, with its three very important heads, is to touch and

leave it as quickly as possible, stating the practice that we have each followed in our respective localities. It is to be presumed that the questions of line and grade and drainage have already been taken care of when we come to the width, the depth and the crown of the road. I think that in the discussion of highway improvement we have been, and are now, foo much inclined to skip by the essentials in road building and leave the primary department a little too quickly and get into the elementary department.

I know that in this question you will all agree with me that each particular locality is a governing principle to itself. The question of material, the question of accessibility or privilege to do is a matter for each locality, and very largely a question of finance. In my own state we were very glad to commence with small beginnings, for we had very little money. The result was that our beginning was in a very primitive way and I think for many years to come—and I don't say it in a discouraging way at all—you will find that with only 10 per cent. of the roads improved, and those which have been improved principally east of the Mississippi River, we will go down to the first principles of road building.

The subject of Mr. White's paper was too large to treat at length, for each one of the subdivisions of the subject is a very important feature in road building. And I often wonder if we do not make a mistake in these discussions in not devoting more time and attention to the great question of the different kinds of pavements that are to be installed throughout the country; taking the shoulders, taking the width of the roads, taking the depths of the roads, taking the drainage of the road and all those constituent parts that go to make up that which constitutes a road, and devoting an entire session to the question of, for instance, a gravel road. Every one of these questions very largely depends on the others. The width of the road has to do with the depth, and the depth of the road has to do with the width, and so it would seem to me that in the discussions it would be wise sometimes to take up the gravel road and take every constituent or component part of that type of road and discuss it—everything connected with a macadam road, and discuss that.

I remember that I was hounded from Dan to Beersheba, from one end of my state to the other—and outside of my state—because I was so strongly intrenched in my views in regard to water bound macadam; but I believe that a macadam road has its place in the world and for many years to come it will be built. I remember that in the great state

of New York where they have millions of dollars to expend in the letting which is to take place in January, over one-half of the contracts that are to be let will be for water bound macadam. Now, that is very largely determined by reason of the fact that it is difficult to get stone in one place, and it is difficult to get gravel in another place, and the question of finance enters largely into it. So I think that the outcome of this paper will be the suggestion that we have the question of the gravel road, the macadam road, the granite block and wood block pavement, the brick road and all those things discussed right straight through from the foundation of the road right up to the finished state.

The width of the road with us was a very difficult matter in my state by reason of the fact that we found a great many of the farmers desired to, and did appreciate their little holdings by just creeping over the fence, shoving it out every time the fence fell down. The grass was very sweet just over the fence, and while originally the road might have been laid out three rods, four rods or six rods wide, it had gradually crept into a smaller space until in many instances the road was barely two rods wide. That may, perhaps, provoke a little smile on your part, and yet the same thing is the curse of the cities of our country. There has been no protection for the city street; certainly not as much for the city street as there should have been. There seems to have been no forethought at all in the early days in the building of our cities as to the question of a building line. If that question of a building line had been as carefully thought out in the early days of construction or laying out of our cities as this question of highway improvements is being discussed by us today, you would not find the condition of congestion that you find both in the street and on the sidewalk that we have in some of the largest and most important cities of our land today. So, I say, that of this great convention and kindred conventions that are gathered together in this way from all parts of this great country, there is no man living who can measure the influence of good that is going to come through the interchange of opinions and views in regard to this great question.

Speaking about the other side, I would not, if I could, decry in any way not only the roads on the other side of the water, but the roads in any city or any state in the country, but you now have a very good demonstration that the roads were not laid out with the view to their future use. It is only two or three years ago when they wanted to connect Holborn with the Strand. It would cost $30,000,000 to make the connection,

but they so provided in the purchase as to get a return from the additional width amounting to $21,000,000, which they used for public purposes after the street had been built. It would seem to me then that the subject-matter of Mr. White's paper will be food for reflection and profit for us for many a day to come.

In the width of our roads we try to establish a width between fences of not less than 12 ft. for the traveled path, 3 ft. for the shoulder or support of the road, and 2½ ft. for the gutter, widening out the gutter as the volume of water and the distance it has to be carried increase. That was only in instances where we were controlled by conditions. We increased that to 16 ft. Of course, when we started in 1895 we had no thought of the automobile which has revolutionized everything connected with road building in our eastern states. That which was good yesterday and took care of conditions that were to be met with will not fit the conditions that we have today. The traffic, as was so well said, will determine very largely what the width of the road should be. Our maximum width is 16 ft. with a 3 or 4 ft. shoulder or a 5 ft. combination shoulder and gutter.

We found a condition to contend with that some of you out in the West don't have to meet. We had no checkerboard plan. It seemed to us in my own little state that there was one special letter in the alphabet that they were specially fond of in the laying out of roads, and that was the letter "S." I have spent more money during the last few years in extending the sight line, in many instances, than I would for two or three miles of road adjoining this particular weak spot. All turns have to be widened where we have the heavy traffic. The curves are banked now, and there isn't very much thought of the roads that are secondary roads.

The depth of the road is very largely a question of subgrade. In the cities it will be necessary to put down good, substantial foundations, for cities are simply little pieces of ground cut off from many farms. Each city block was at one time either given up to timber or a part of a farm, and there was no line and there was no grade. As this great city of Chicago grew into the position for line and grade, it was a dumping ground for all kinds of material—sand, gravel, ashes and refuse of all kinds. While we put the foundation under the country road to suit each particular condition we can't do that very well in your city streets. The day has come when the city street is one of the most important factors that you have to consider in taking care of the interests of the city, for today that which is under the street is quite

as important in its function as the traffic that is carried over it, or the business that is abutting the street. All these things that we have discussed today as foundations for city streets will have their day. They will have their generation and, like everything else, in obedience to the march of civilization and intelligence it will be necessary to change things as the necessities of the hour may dictate in order to meet each particular condition as it has to be met with.

In the early days of my state it was necessary to clear the land, to grow the crop, to take care of the little home, and to take the stones cleared from the land and put them in a fence. Now, as these stones have performed their function until now and as we have the money with which to do, we take the stones out of the fences and place them in the road and make a good, strong telford base to carry the produce that has been grown on the farm to its nearest and best market place. That can be done and, in my judgment, there is no foundation today for a country road that is equal to or as good as a well built telford base. It is resilient; it will bear repair; it is easily constructed. It is a simple process to take from the fences the stones ranging in size from 10 to 15 or 18 ins. long, from 6 to 8 ins. wide, and from 8 to 10 ins. deep, lay them vertically in courses across the road with the broadest edge down, and with not too many small stone, bond these stones and then wedge them up and break them back. Then you have a foundation that will stay there for a thousand years; that in obedience to the demand of the traffic in the future will sustain it and take care of it.

I always believe that the essentials in road building are the question of water reduction, the question of drainage, the question of width of road and taking care of the sight line. When you have those and the question of foundation you will have the essentials of road building, and they will be the essentials for many years to come. The question of surface will always follow naturally in obedience to the traffic that it is called upon to sustain. The question of the depth of stone and the question of the foundation are matters that force themselves into the matter of traffic conditions. If we build a good gravel road, we have to start with the foundation. We see to it that there is nothing there which is likely to heave, yield or settle, and that all vegetable matter is taken out. The foundation was put in right to start on, and then we arranged for a gravel road covering three courses, two 3-in. courses and one 2-in. course. That was for our best gravel roads. We built some other gravel roads that

were not quite so heavy. The well-built gravel roads are laid in courses and built with stone ranging in size from 1 in. to 3 ins. for the first course with 80 per cent. gravel and 20 per cent. bonding material. The second course is of stone ranging in size from 1 in. to 2 ins. in the longest diameter of the stone, the smaller size predominating, starting with 80 per cent. gravel and 20 per cent. bonding material, and the top course is 2 ins. deep with no stone exceeding 1 in. in the longest diameter with 60 per cent. of gravel and 40 per cent. of bonding material. If the courses are rolled wet and put in condition they will make as fine a road to travel upon, for the condition that it has to meet, as any road that I know of.

As regards the cross grade, I think that that is one of the things that is important. In a gravel road, as Mr. Hirst very well said, it settles very easily. I have always specified for gravel roads, however, that when they are finished, they shall not show a mark of hoof or wheel. The engineer in road building is supposed to arrange a standard that won't leave any doors or windows in his specifications.

We build our macadam roads 7 ins. deep. We use that depth so that the smaller stones predominating will make a solid and compact road before the roller is put upon it. We bonded the road from the top. We didn't care to have very much of the screenings with which to bond the road; simply enough to assemble it and to tie it. We depended for our bond upon the small stone that we had in the aggregate rather than in the screenings. That was a 7-in. treatment, two courses of 3 ins. and a top course of 1 in.

For the crown of the road I established from the start the ¾-in. grade—¾ in. to the foot on the gravel road or the earth road. I established a ⅝-in. grade on the macadam road so as to distribute the travel. I believe in many respects that this question of the proper grade of the road has more to do with our problems than anything I know of.

The hog-back road is a curse to this country. When you have one of these roads that run from 1 in. to 2 or 3 ins. to the foot, and a team goes over that road after you have constructed it and spent your money, I don't care what the road has been constructed of, or with, you are getting, no matter what the width that you have paid for, exactly as a compensation for the money invested just the width occupied by the two tires, or the four. If they are 4-in. tires, you are getting 8 ins., and that is what you are getting for paying for a 16-ft. road. In the hog-back road, with an excessive cross grade, you have either got to stay in the center

of the road or go into the ditch. It adds to the length of the life of the road when you flatten the grade, because such a crown is an invitation to use every inch of that road. The result is that you have used your money wisely.

When you get down to the question of grades and width of roads and depth of material you are discussing very important matters, and you are discussing matters that many times are not up to the engineer in charge of the work. Many times when we are inclined to criticize we should remember when we talk about the work the engineer has done that "Each man is a world to other world's half known, and turns on a tiny axis of his own, and his full life's orbit is a particular wisdom in those brother planets that revolve with him." And so I have noticed that many times you will find in a city, in a residential place, a pavement that should have been on a business street, and a business pavement laid on a residential street; simply in obedience to some one who had the influence to bring that about. But this whole question is one that is broad enough to take care of it, and I am glad to see that this association has within its functions the privilege of starting a fire, kindling something that cannot be quenched, and has an influence for good throughout the length and breadth of this country; that engineers will be protected, that men who have charge of public work will be helped and assisted materially by just such an organization as this is, doing all that within them lies as is given them light to see their duty, to do it, and that as the work of this great association goes on its influence for good will be felt further and further until the whole of this great country will become what it was meant to be, not only first in arts, first in science, first in everything that goes to make a great country such as we all delight in, but will be first in this great influence of highway improvement. I thank you. (Applause.)

CHAIRMAN DEAN: The next gentleman, Harold Parker, advised me about ten days ago that he would not be here. It would appear that there will be hardly time to have any open discussion on this paper, and to complete the rest of the forenoon program. Should the discussion of the next paper terminate early enough, if there is any one who desires to discuss either paper there will be an opportunity. The next paper is "Road Foundations—Concrete, Telford, Gravel, etc.," by Mr. J. A. Johnston, Division Engineer, Massachusetts Highway Commission. Mr. Johnston. (Applause.)

Road Foundations—Concrete, Telford, Gravel, Etc.

By J. A. JOHNSTON
Division Engineer, Massachusetts Highway Commission

While vast sums have been, and are being, spent on roads, the work to be done is so enormous that the problem can only be solved by true economy, and it is not a question of what material possesses theoretical advantages over another, but what will give us the most for our money; not merely the most roads for if your roads are not properly built added mileage means added burden of maintenance; while on the other hand, if your first cost is more than conditions warrant, the interest on the investment may exceed the maintenance on a poor road. Of course the first problem in road building in its broad meaning, is the location and gradient, but in the more narrow acceptance of the term road building (meaning the traveled surface) the main factor is the foundation.

What to Use for Foundation—where—how—when—and quantity to use, is the science of road building. Many men have attained enviable reputations as road builders based mainly on the fact that their work was all done in a locality which was blessed by nature with favorable soil conditions.

In our earlier work, in Massachusetts, it was our practice to use foundations only in such locations as were unquestionably bad, and to take a chance on such places as were in doubt. We believed it was cheaper to later strengthen the weak places than to use extra material that might not be necessary. Under conditions then existing with comparatively light horse-drawn traffic and with mainly gravel and water bound macadam surfaces, this "take a chance" policy seemed a reasonable one, but, no one could predict the future developments and I doubt if we have actually saved any money by such attempts at economy.

Many road materials have been unjustly condemned when the real difficulty lay in the foundation and not in the surface material. There are many companies advertising their road materials as the final solution of the road problem, when as a matter of fact, their specialties are merely surfacing propositions, many of which would give excellent results if used over a proper base, but are far from being the whole road as one might infer from their claims.

Surfacing is secondary to foundations. We have taken old worn out macadam roads, rejuvenated them with a bituminized surface at a total cost of 10 cts. per square yard; maintained them in excellent condition for four years at an annual cost of 0.1 ct. per mile per vehicle, or about 1.4

cts. per square yard. On the other hand, we have all seen roads where the surfaces alone cost from $1.50 to larger sums per square yard for 2 ins. of bituminized material, which have failed, and gone to utter ruin in a very few years; not because the traffic conditions were so severe, nor because the surfacing material was poor, but solely because they were built without a proper base under them.

The statement has many times been made that a waterproof surface requires little or no foundation because no water can get through it to the soil beneath so the base is kept dry. Many horrible examples might be cited to show the fallacy of this belief. A little consideration of the capillary action of the soil which draws water from the sides of the road and underground sources, as well as the water that will seep through the soil from higher points, will show that a waterproof surface is not sufficient unto itself without a proper base. It must be understood that each road is a problem in itself and no standard treatment can be devised that will fit all conditions. There are many factors entering into the problem; soil, drainage, traffic, available material, all should be considered.

In some localities good gravel can be had at a low cost, but there are many places where good gravel would have to be hauled many miles, and the cost would be prohibitive. In other places stone is abundant and cheap, while in others there seems to be no material fit for foundation purposes and all must be shipped in.

It is true that if you can obtain the right kind of gravel, it makes an excellent foundation, but to give the best results it should be absolutely free from clay, loam or silt, and rather sandy. For instance, on such a base we have built macadam roads with only three inches of broken stone. There were a few soft spots in the spring where pockets of loamy gravel were found, but these were taken out when they developed, and one such road, which carried a considerable traffic, on the edge of a flourishing Massachusetts village, was kept in excellent condition at a low cost for maintenance for twelve years before it was resurfaced. In another place we built a section of road over a very soft bottom (practically quicksand) by first placing a bed of gravel 18 ins. deep, and over that 6 ins. of macadam. This road has been built sixteen years and has given no trouble. On the other hand, we have many miles of road built on gravel bases 6, 12 and in some cases 18 ins. deep, that soften up and rut badly in the spring when the frost is coming out. It is our practice to carefully locate all

soft spots in the spring so that when funds are available for rebuilding such roads we may remedy the defect without guesswork.

Most gravel contains enough silt, loam or clay to so draw moisture by capillary attraction that the frost will work in it and, of course, when the frost crystals thaw, it leaves the material porous, spongy and wet. This condition is aggravated by the rolling wheels passing over the surface and the tamping action of horses' hoofs, which all tend to puddle it just as a tamper puddles concrete, drawing the moisture from below. Such a result, unless extreme, may not be serious if your road surface is of gravel or even water bound macadam, for such surfaces are easily and cheaply repaired, but if the road surface is a high cost bituminous mixture it may be ruined, and we cannot afford to take such chances. It should, however, be borne in mind that a road may stand two or three years over a poor bottom with little apparent trouble, but almost entirely go to pieces the third or fourth year. This fact has caused a great deal of trouble; for the inexperienced man finding that a road stands all right the first year assumes it will continue to do so, proceeds with the same type of construction under similar conditions until the first fails and the whole road is soon ruined.

Gravel alone cannot safely be trusted for foundation, and should never be used under a high cost surfacing except as a sub-base under stone foundation or concrete.

In our earlier work we depended largely on side drains built 3½ ft. deep at the edges of the macadam. A 5-in. pipe was placed in the lower part of the trench and the drain filled with small stone fragments. Our theory was that these drains would dry out the subgrade and keep the road surface firm. We built miles of these drains, but they did not accomplish the desired results unless they were supplemented by a stone base under the macadam, and subsequent experience has shown that, except in rare cases, if the road is built over a proper stone foundation, the side drain is unnecessary.

One of John McAdam's theories was that no stone larger than you could hold in your mouth should be used in a road. Now I have a large mouth, but it won't hold as large a stone as experience has proven to give satisfactory results for foundations in Massachusetts.

In the last 20 years we have tried many methods of subsoil drainage and many different forms of foundation. On some of our macadam roads with crushed stone 6 ins. thick the road has after one or two years softened up badly in

the spring. We tried the experiment of adding more crushed stone, without breaking up the old surface. In some cases we added 12 ins. of new stone, making a total of 18 ins. of stone fragments not exceeding 2½ ins. in their largest diameter, and also built ground water drains each side of the macadam, and cross drains at 50 ft. intervals. The result was a failure, for after two or three years the road broke up as badly as ever. As these results were obtained in several places, I think we have proven crushed stone of small size is not satisfactory for foundation and is suitable only for surfacing. My theory of this is that the units are so small they have little bearing, and as they have no cohesion when wet sink readily into the mud. Regardless of theory, the fact remains that is the effect; and some of these stone particles have been found a foot or more below the original subgrade.

It should also be borne in mind that the cost of the crushed stone is nearly three times as great as that of the larger size fragments. As some one may take issue with this statement, I will illustrate: Under sharp competition our average contract prices for field and wall stone, rolled and measured in place in the road, is about $1 per cu. yd. Our average price for crushed local stone, finished in place in the road, is about $1.50 per ton. A 15-ft. road 4 ins. deep requires about 36.4 tons per 100 ft., exclusive of the dust used for binder; this is equal to 2 tons per cu. yd., or the crushed stone at $1.50 per ton equals $3 per cu. yd. It is, however, true that if the road were all crushed stone the unit price would be 25 to 50 cts. less per cu. yd.

When we first began building our roads, if we found a place which seemed to need a stone foundation we used a telford paving 8 ins. deep over 6 ins. of gravel. The telford stone were set up on edge, the tops broken off to a true cross section, and the joints wedged up and chinked. French drains 3.5 ft. deep were built at each edge of the road. These drains cost 35 to 50 cts. per running foot. A year or two later the specification was changed and the telford was only 6 ins. thick over 2 ins. of gravel, with the continued use of the side drain. The cost of this lighter telford was about the same as the thicker, and as the hours of labor were decreased and price per day increased we paid as high as 50c. per sq. yd. for some of this telford. Later we abandoned the standard telford and adopted the "V" drain, so called because it was roughly the shape of a broad "V" about 18 ins. deep in the center and 4 ins. at the sides, with stones not over 8 ins. in their largest diameter.

The cost of this foundation for stone in place in the road runs from 75 cts. to $1 per cu. yd., or about 25 to 33 cts. per sq. yd. of road surface. This "V" drain is a combination of foundation and drain, the water flows in a channel in the center of the road, whence it is led off by bleeders to proper outlets. We built many miles of these drains or foundations only 10 ft. wide under macadam 15 ft. wide. This gave satisfaction in the earlier days, for the traffic did not spread over more than 10 ft. except when passing another vehicle.

While this practice was satisfactory under the old conditions, it has now been discontinued, because it is found that, as the high speed motor requires more room in passing, the whole width of the road is used. In fact, on our main roads we have been obliged to increase the width of the hardened surface from 15 ft. to 18 ft.

One objection to the "V" drain is the fact that, owing to the extra depth of stone in the center of the road, the frost action is not as great at that point as at the edges, where the stone is lighter, and a considerable distortion is occasioned in the road surface. When the frost enters the ground, the lighter sides are raised more than the center, with a resulting concave surface; later, when the frost is coming out, the sides thaw out more quickly and there is an exaggerated camber. These extremes do little or no damage to a surface of gravel, macadam, or a soft bituminous matrix, but the more rigid forms of surfacing would be disintegrated.

Because of these inherent defects in the "V" drain, we have for several years been building stone foundation with a flat subgrade. If the bottom is a soft clay or silty material, which would work up into the voids of the stone foundation, we first place over it a bed of sandy gravel, when such material can be obtained, varying in thickness as the conditions may require, in some places 6 ins., in others 12 ins., and over this stone fragments not exceeding 8 ins. in their largest diameter. The depth of this stone foundation is never less than 8 ins. in the center and 4 ins. on the edges, and under extreme conditions we have used 18 ins. in the center and 14 ins. on the edges. No attempt is made to place these stone as a paving, though some care is taken to lay the bottom stones on their broadest face to ensure a substantial bearing.

I am aware this is contrary to the theory that a stone laid flat will tilt and cause trouble, and that the usual practice is to place telford stone on edge, but without discussing

the matter further at this time, I can assure you we have built many miles in this manner without trouble. Small stones are thrown on top to close the surface crevices, the whole is then rolled with a steam roller until hard and firm. This thorough rolling we believe to be one reason for freedom from trouble from tilting stone. If a bituminized surface is to be placed on the road the voids of the sub-base are filled with clean, sharp sand (and we insist that this material shall be clean), this is rolled without wetting and any surplus that remains on top of the base is swept off. This sand filling, however, is not an essential part of the base, but is used only to prevent the loss of bitumen. Bleeders are used, to drain the water from this foundation, at proper outlets, and care is taken to so build these outlets as to avoid future clogging.

Foundations of this description have a fairly uniform frost action, appear to be preferable to the "V" drain and have been satisfactory. The costs, of course, vary with the conditions, running from about 15 to 60 cts. per sq. yd.

If a surface of wood, stone or brick blocks, or the more expensive types of asphalt is to be used, a concrete base is accepted as the best practice. It is open to some objections, such as the delay incidental to proper setting of the cement, and the fact that because of its rigidity it will crack under irregular frost action in mixed soils. We have all seen the result of this latter trouble in badly cracked pavements over concrete bases.

On the other hand, the cracks can be largely guarded against by proper drainage and it seldom cracks enough to cause disintegration, while if the cracks are due merely to frost action, they practically disappear (unless they are extreme) when the frost is out of the ground. On this, as on other forms of foundation, the engineer's good sense, and experience may save much unnecessary expense. I have seen a concrete base, 1:2:4 mixture built 12 ins. deep over a natural bed of excellent gravel, where to use over 4 ins. was criminal extravagance. I have also seen 4 ins. of concrete used over a bottom where fairly hard soil and soft muck holes alternated, and the engineer in charge of this work could not understand why this pavement cracked so badly the following spring.

There is some difference of opinion as to whether it is better to build a fairly light base of strong concrete (4 ins.) of 1:2:4 mixture or a heavier base (8 ins. or more) of a leaner mix, 1:3:6, 1:4:8, or even a smaller proportion of cement. Conditions should decide this. In a mixed soil

better results might be obtained by the greater depth of the lean mixture, as there would be less frost action at the greater depth, and the increased depth of the concrete slab should more than offset the loss in tensile strength of the material.

Of course, if it is planned to build a concrete road surface with the ultimate idea of surfacing it at some later time with bitumen, or other material, there is no room for argument as to the use of a rich mixture, for it is then necessary to so mix your concrete that it will withstand the abrasion of the traffic. If the bituminous surface is to be only a light one it is still advisable to use the rich mixture, as the shock of the passing traffic may cause enough surface disintegration to destroy the bond of the bitumen to the concrete.

Before closing I am tempted to refer to what appears to me an absurd action on the part of certain parties interested in bituminous surfacing processes who have been flooding the country with pamphlets attacking concrete roads. I hold no brief for concrete roads, but recognize their good points and recommend their use where I believe them best adapted to the conditions. There is certainly very little room for argument that under most conditions concrete makes an excellent foundation for a bituminous surface, so if, as these parties claim, concrete road surfaces are failures, they surely can be used as bases for bituminous surfaces, and the more concrete roads that are built, the more foundation will be ready for bituminous surfaces.

In conclusion, gravel, stone, concrete all have their places. There is no sovereign remedy for all conditions, and I wish to emphasize: To get the most for our money, each road must be considered a problem in itself.

PRESIDENT McLEAN (Succeeding Vice President Dean in the Chair): The discussion of the paper which has just been placed before you will be introduced by Mr. George W. Cooley, State Engineer of Minnesota.

A. D. GASH: Mr. Cooley went home last night.

PRESIDENT McLEAN: Mr. Cooley is gone. The next speaker will then be Mr. W. S. Keller, State Highway Engineer of Alabama. Is Mr. Keller here? Mr. Keller not here?

James R. Marker, State Highway Commissioner of Ohio. We are getting through the program at a good pace.

Mr. R. C. Terrell, State Commissioner of Public Roads of Kentucky.

R. C. TERRELL (State Commissioner of Public Roads of Kentucky): Mr. Chairman and Gentlemen of the Convention: You have heard this very interesting paper by Mr. Johnston and its discussion, from a northern standpoint. Conditions prevail in the East that do not prevail in the South. From a Kentucky point of view it is not necessary to put in a heavy telford foundation.

I think that Mr. Johnston's main trouble in the sub-soil proposition was, as he stated, that for the first two or three years the road held together very well, and that after that time it began to break up. This is due to the fact that the small tiles used—the 4 or 5-in. tile used under the stone foundation, under the stone drains at the side—become clogged and allow a seepage of water under the road that causes that action in that particular territory. Where the sub-soil is properly drained, especially as it can be in the South where the frost action does not occur materially, you don't find that upheaval of the macadam or gravel road surface in the spring season, at least, to only a very small extent. The passing of a roller over the road in the spring will eliminate practically all rutting of the road. The gutters as well may become entirely frozen, if the water is frozen at the mouth, and become a solid line of ice, which permits a surface seepage of the water under the road.

From the southern viewpoint, that does not appear. We have about 10,600 miles of macadam and gravel road in the State of Kentucky, and of that total mileage I dare say there is less than one thousand miles of telford foundation road. That road was constructed in the early days when the engineers were strong believers in the telford foundation, coming from the North and East where the frost action prevailed. In the later methods of construction it has been entirely omitted. The earth has been graded up to its proper cross section, side ditches have been provided and the stone has been rolled down on the foundation. At first small stone was used but practice has shown that 2½ to 4-in. stone in the 4-in. sub-bottom course, properly rolled down will give a satisfactory foundation, with a 3-in. course of smaller stone and then the necessary screenings for a binder.

This type of construction is also used for the gravel road and from the Kentucky point of view it isn't necessary to have the gravel free from loam or clay. About 15 or 20 per cent. of clay is a decided advantage in gravel and usually is mixed in the gravel bottoms at about that proportion, so all that is necessary is to put on 8 or 10 ins. of good gravel and roll it down on a proper foundation with a subgrade of

earth, and we have an excellent road that will last for a considerable length of time. There are few other points that I care to discuss in this paper at all. I am sure that Mr. Johnston has covered the main part of the subject excellently. I just merely wanted to call attention to the conditions that prevail in the Southern States. Thank you. (Applause.)

CHAIRMAN DEAN: The next gentleman is Mr. John H. Gordon, a contractor of Albany, N. Y. Is Mr. Gordon present?

Gentlemen, the day is still young. You will now have an opportunity for some discussion. I think it would be well to start the discussion on the last paper first, inamuch as that subject is, of course, now fresh in your minds. Is there any one who desires to say anything in regard to what has been said, or to make any additional remarks on the matter of foundations?

L. DREW GODDARD (City Engineer, Laporte, Ind.): I have some old macadam roads and it is desired to use that macadam road as it is for the foundation of a brick pavement. I heard a statement made in another engineering convention that trouble was experienced from the sand cushion working its way down through the macadam road. I want to know if that trouble is general.

CHAIRMAN DEAN: I think I shall call upon Mr. Tillson, being the expert on wood block paving.

GEO. W. TILLSON (Consulting Engineer to the President of the Borough of Brooklyn, New York, N. Y.): Mr. Chairman, this was a brick proposition as I understood it.

CHAIRMAN DEAN: Any paving; city paving.

MR. TILLSON: Mr. Chairman and Gentlemen: I should think that in such a case that if the macadam pavement were in reasonably good condition and were not likely to be disturbed after the brick were laid the old macadam would make a first-class pavement foundation. We have, I know, an asphalt pavement in the Borough of Brooklyn that was laid some fourteen years ago on a macadam foundation. It happened to be in a part of the borough where although the traffic was heavy there wasn't much digging up or disturbing of the base. We got excellent results from that. If your macadam is old and has been in use four or five years, so that it is thoroughly compacted, I do not see how any sand could get down into interstices of the macadam because the macadam must during that length of time, I should think, fill them absolutely full. The objection that I see to laying a brick pavement on a macadam foundation as it happened to be, is that the sand cushion would be uneven.

That is, in some places you might have only ½ in. of cushion and in some places 1½ ins. If your macadam base were uneven I should want to bring it up to a reasonable surface with small broken stone rather than lay the sand cushion directly on the old macadam, so that the sand cushion might be as nearly uniform as possible over the entire surface.

CHAIRMAN DEAN: Has any one else any questions or remarks?

C. A. KENYON (President, Indiana Good Roads Association): In many places it is a constantly growing question what we are going to do with the worn-out macadam surface in order to put some other surface upon it, where the traffic, as has been the case over at Laporte, becomes too heavy for the macadam.

I went over a number of roads with engineers in England last year and they had, I found, adopted this form of construction to meet conditions there. They do not lay much brick on old worn-out macadam, but they lay what they call durax. This is a small stone, which they can purchase from the quarries as they can stone they call tarred stone. The latter is stone mixed with thin tar so that it can be shipped and used cold. They don't have to have it heated as they do screenings or No. 2 stone. They fill up some of the deeper depressions with that first, then tamp it down and then lay a seal coating on that; then lay the blocks on top of that with most excellent results. They were finding that in the cities where they had block pavements of wood and granite, the blocks under the heavy traffic of motor buses were being pushed into waves on account of the sand cushions underneath. They found that by putting these little binders, as the asphalt men call it, underneath either a granite or a wood block pavement, they absolutely stopped that waving motion from the heavy traffic afterwards. So by that little binder in the bottom, whether it is on an old macadam road or on a concrete foundation in the cities, this heavy traffic on the granite blocks or wooden blocks may be taken care of with very excellent results. (Applause.)

F. W. PATTERSON (The Cleveland Trinidad Paving Co., Cleveland, Ohio): The company I represent has laid many miles of resurfacing over macadam, brick and cobblestones, and other contractors have done the same. We have laid asphalt, asphaltic concrete and other types, which seem to me to be, and indeed are, the proper wearing surfaces to apply on old foundations. I thought I would bring that matter to your attention, for I can refer to a number of

pavements that have been laid by the company I represent. For instance, in Columbus, Ohio, there was a cobblestone pavement laid in 1904 with a sheet asphalt surface that has required no repairs. We gave a guaranty of five years, I believe, and during that time we were not called upon to make any repairs. If there is any information any person wants concerning this subject we shall be glad to furnish it.

CHAIRMAN DEAN: The President has asked me to announce that at the close of the afternoon session today there will be a business meeting of the Association at which a matter of considerable importance to the Association may be acted upon. Are there any other gentlemen who would like to speak in regard to road foundations?

JAMES H. LOWRY (Executive Officer, Department of Public Parks, Indianapolis, Ind.): In construction of levee embankments to be used as boulevards along the streams in the city of Indianapolis, it became necessary, for flood protection purposes, to remove certain obstacles from the stream and to obtain practically all of the levee material from the stream proper. The material was, of course, cleaned, consisting largely of gravel running from 40 to 60 per cent. sand. In constructing the levee, which was in many places 18 ft. deep, it was impossible as well as impracticable to attempt to roll the material as it was being placed, owing to the manner in which the fill was being made. Where there was a fill in the construction of the roadway varying from 6 ft. to 18 ft. in depth, much trouble was experienced in getting a foundation on which a first-class gravel road surface could be quickly obtained.

Possibly some one present has had a similar experience and might give us some suggestions that will be of assistance in this work. We have at the present time about three miles of this type of roadway under construction and will soon commence to finish the surface for traffic use.

CHAIRMAN DEAN: We will be glad to hear from some one else on this subject.

F. E. ELLIS (Manager, Essex Trap Rock & Construction Co., Peabody, Mass.): I was in Buffalo last Saturday and on one of their boulevards they were taking up a piece of water pipe or something and I noticed where they cut down for the trench that the road had been surfaced with sheet asphalt on the old macadam foundation. The parkway, when it was originally built, was built of water bound macadam and, I learned afterwards that about six years ago they surfaced it with sheet asphalt. That surface is in excellent condition and is in a great deal better condition

than some of the roads near there that have been built of sheet asphalt on a concrete foundation.

W. F. SARGENT (Commissioner of Public Works, Oak Park, Ill.): Nothing has been said so far, I think, as to the use of an old sheet asphalt pavement as a foundation for laying another pavement. It happens that within the last few years we have built several miles of that pavement with what we think remarkably good results. I speak of this because during the past year I passed through the city and noticed that they were simply ripping out all the old asphalt and throwing it away, and it seems to me it is wasted.

J. W. LOWELL (Universal Portland Cement Co., Chicago, Ill.): Mr. Chairman, Mr. Johnston stated that stone and tile drains in the side of roads were, in his experience, found not to be satisfactory or did not give results. Mr. Terrell made one explanation. I would like to have Mr. Johnston go into that further, since that type of construction is uniformly used throughout the North and West to a great extent.

CHAIRMAN DEAN: I think Mr. Johnston would be very glad to elucidate a little more.

MR. JOHNSTON: We opened up some of these drains and did not find them stopped with silt. It is possible, of course, some of them may freeze in the winter time, as Mr. Terrell suggests, but we do find that if the same amount of money that the drains would cost is put into extra base, we get a surer result than we do with the side drains. If the water won't leach through the soil, it won't leach into your side drain.

Mr. Terrell's point is that they don't get much frost, and there is no question but that that makes a great difference. If they do not have frost action I don't doubt that the drains work better.

I don't mean to say that we have abandoned them altogether. If we are building in a very wet place and we have got springs and water to be tapped and carried away, we use them. We do not use them as we formerly did, because we feel that we are better off with the heavy foundation under the road than with the indirect method of side drains.

The side drains would cost up to 50 cents per running foot. We sometimes had them on both sides of the road. This would cost $1.00 per running foot and $1.00 per running foot would add nearly 1.5 ft. in depth to your foundation, assuming stone fragments to cost $1.00 per cu. yd. in place on the road, which is about the average cost in Massachusetts.

CHAIRMAN DEAN: This is quite interesting, gentlemen. Has some one else something to offer on this subject?

W. A. HEIMBUECHER (City Engineer, Universal City, Mo.): I would like to ask Mr. Johnston how much rolling they do to the subgrade. I have found in my experience with street contractors that where there is quite a bit of cutting in one place and light filling in in another, where they use a steam plow there is a tendency to cut heavy in spots and light in others and then they have to do the shaping with wheelers. Of course, that gives you a very unequal foundation and unless it is very thoroughly rolled, it is bound to fail later on. In the pavements I have looked over in my experience I have attributed the failures mainly to not rolling the subgrading and getting it into a hard condition. I would like to know if any one else has had any experience of that sort. I think the rolling of the subgrade is as of much importance as the placing of the concrete.

MR. JOHNSTON: We do roll the dirt subgrades, of course, but I sometimes think the necessity for that is somewhat exaggerated. This doesn't mean you shouldn't get the settlement out of your material, but oftentimes in a soft bottom it is almost impossible to roll it, particularly if the soil is sandy. Of course in that case the rolling isn't as necessary, for the sand can't be compressed a great deal. But, with us, where there is to be a foundation on the subgrade a lack of preliminary rolling is the contractor's own loss, as our method is to pay for the foundation stone in place in the road, and we insist that the surface of this foundation must be firm and true after thorough rolling. Then it is up to the contractor. If he doesn't roll the subgrade, it is his loss. He is paid for only a certain depth of stone in the road. He can take his own choice. If he thinks it is cheaper to put the stone in and let it sink out of sight into the soft bottom, he must add more stone to true up the surface, and he pays the bill.

[NOTE.—Upon the submission of proof of this discussion to Mr. Johnston for correction, he made the comment which follows.—Ed.]

In looking over these remarks I find I did not grasp Mr. Heimbuecher's comments. My answer referred to ordinary macadam or bituminized stone roads, while he refers particularly to roads with a concrete base. For such roads I agree with him that it is essential to thoroughly compact the dirt subgrade.

CHAIRMAN DEAN: Has any one else anything to say on this subject?

W. P. COTTINGHAM (Assistant City Engineer, Gary, Ind.): At Gary, the steel city, we are using iron ore slag from the blast furnace. We find that it makes an excellent base for anything you want. We put an asphalt surface on an old slag macadam pavement and we found in tearing that up that the slag had given us an excellent, well-bonded base. There seems to be a chemical action in the slag. It is the same slag that is used in the manufacture of cement, and when it is rolled it works up and cements the material together on top of the base. The slag itself makes an excellent base for macadam. The city and county have used considerable of it.

CHAIRMAN DEAN: Are there any more comments?

MR. WHITE: I felt like saying just a word more on the use of old macadam for foundation. In Chicago here we have some examples of that, and one that I have particularly in mind is Michigan Avenue where the old macadam was used as a foundation for sheet asphalt. Between 12th and Jackson Streets there was an old macadam pavement over which asphalt was laid. This asphalt was in use—I am not sure just how many years—but I am sure it was over 12 years, when it was torn up because of the widening of the street—not that the macadam nor the asphalt was entirely out of service. At present there are several blocks of asphalt pavement on Michigan Avenue, particularly I will say between 12th and 16th Streets and between 18th and 22nd Streets, where the asphalt pavement is on old macadam, and these pavements are from 12 to 15 years old now, some of them. In recent years in the extension of the pavement on Michigan Avenue as well as on other Chicago boulevards, we have continued to utilize the old macadam base just as far as possible believing there was no economy in the destruction of a well-bonded macadam that had received the compression of years—no economy in taking that out and putting in concrete or any other sort of new base that we could devise. There are a great many miles of that sort of pavement in Chicago now carrying a bituminous wearing surface.

MR. LOWELL: I would like to ask Mr. White a question Mr. White, isn't that more for boulevards than ordinary streets? I have in mind a pavement of that sort on Diversey Boulevard which was open to traffic of the heavier vehicles. I don't believe that has worked so successfully. I wondered if that practice wasn't more universal on boulevards than on other streets.

MR. WHITE: Yes, I think that is correct. I don't believe it is true that a macadam base will compare with a good con-

crete base for heavy traffic purposes and I should say it ought to be used for boulevards, residence streets, and comparatively light traffic streets, where the macadam would be of most value. I don't think that sort of a base is a suitable base for heavy traffic streets.

C. P. PRICE (Manager, American Tar Co., Boston, Mass.): Do you make any repairs to the old macadam surface before applying the sheet asphalt?

MR. WHITE: Generally, yes. In some few cases it may be found the macadam is in a suitable condition, but we generally consider that the macadam must be fairly even. There must be no considerable depression in it that would occasion a great deal of difference in thickness of the wearing surface or anything like that, and again we think the macadam must not have a dirty, fine grained, dusty appearance. We want the macadam to be rather clean so that the surface can get hold of it, so that the bituminous material can get a grip, as it were, on the base.

MR. ELLIS: I would like to ask Mr. White a question. Isn't the traffic on Michigan Avenue far greater than it would be on any of the state trunk line highways outside of the city?

MR. WHITE: Well, to a very large extent teaming traffic, that is, heavy trucking and that sort of thing, is excluded from such streets or boulevards as Michigan Avenue, but there is a certain amount of traffic of that character even, that necessarily goes over it for short distances. Also, traffic of course passes over the intersections without any restriction, and at many of these intersections the pavement receives not only the boulevard traffic but the heavier traffic of the cross streets. As to the intensity of the traffic on such a street as Michigan Avenue—by intensity meaning neither heavy nor light traffic, but a rapid traffic—hardly any comparison could be drawn. Of course, if you figure the number of vehicles and if you convert that into tonnage, Michigan Avenue unquestionably is carrying an extremely heavy traffic which I think hardly any highway considered as a suburban or a state highway would ever be called upon to bear.

MR. KENYON: Have you taken any census of the traffic on Michigan Avenue?

MR. WHITE: We have taken no census of the traffic this season—that is, for the year 1914. We have no complete census of the traffic. In 1913 there were certain portions of Michigan Avenue—say at about 16th Street, which is the dividing line between downtown and loop traffic and the more outer traffic—where it would range from 10,000 to 15,000 vehicles per day of 24 hours.

JOHN R. BENTLEY (Contractor, Cleveland, Ohio): In answer to the inquiry of the gentleman here as to laying brick pavement on an old macadam street, I might say that I laid one street in the city of Cleveland—15,000 yards on Euclid Avenue, one of our very heavily traveled streets—on a macadam base. The surface was not what it should have been. It was pretty well worn out, but we simply scarified it, leveled it and put on a 1½-in. cushion and laid the pavement. It went out of guarantee this year, and I didn't spend a cent on the guarantee except in two depressions that were caused by old box drains that had been put in before the macadam pavement was laid. That was probably 15 years ago. The box drains had disintegrated and had finally settled and let the pavements down in two places.

I have enjoyed the papers very much and the discussions. There is one point that was brought out in one of the papers as to the distribution of the weight over the foundation which I take exception to. That is this: The gentleman contended that the distribution of the load of a 4-in. tire would radiate out 45 degrees, and consequently you could figure on that basis. I don't think that the engineers should figure on that basis. I think they should figure on the weak points, not on the general distribution of the travel, but they should take into consideration all the weak points in the street. That is the trouble with our pavements today. We have not been getting the foundations that we should have gotten. The result is, as was brought out in one of the discussions, that if there is a weakness it develops during the first year, or possibly the second, and you can go and repair it. Then you wouldn't have to figure on heavier construction because those defects could be taken care of as they developed. That is quite true, but the contractors are the goats. They are the fellows that have got to make the repairs and I think the time has come when the engineers and the contractors should get together and agree on the proper construction of the roads and pavements.

ROBERT J. H. WORCESTER (Superintendent of Roads and Bridges, Concord, Mass.): Regarding old macadam as a foundation, we have a stretch in the center of our town where sheet asphalt about 4 ins. thick on macadam and gravel has been down for about four years, and this stretch is right in the center of the business district and gets the through traffic between Boston and the western part of the state. On a Sunday afternoon this summer we took a census, and we counted 600 automobiles in one hour. We also get the farm

traffic on the way to Boston, and all the teams coming to town and stopping in front of the stores. The maintenance charge on this stretch for the past four years has been about $40 for the one or two places that have settled.

H. W. DURHAM (Chief Engineer of Highways, Borough of Manhattan, New York, N. Y.): I just want to say a word in reference to the question of the foundation which I have heard brought out. It seems to me the type of foundation is very largely a local one. If you have under your pavement a class of material that will not settle or give in any way, whether you use old macadam or new, there is no necessity for a heavy foundation.

Something was said about street openings. Some years ago I had charge of the construction of pavements in the city of Panama, and that city is built almost entirely on a hard, almost rock-like clay so that any excavations could be made without bracing the sides. We found that with the exception of the principal streets where we put down a 6-in. foundation and on some of the minor but still important streets, where we put down a 4-in. concrete foundation, all under a brick surface, we got absolutely satisfactory results by building to the proper crown a foundation of macadam, formed in many cases by breaking up the old cobbles which had formerly paved the streets, crushing them and rolling them with a mixture of sand, or, in many cases, out of old broken brick that had been destroyed or damaged in shipping. There was no tendency to settle. We laid the brick directly over the sand cushion and that pavement has given satisfactory service for ten years.

Going over the roads and city streets that you find abroad as well as here, some of the best roads that are encountered, particularly in Europe, have absolutely no foundation other than the original surface beneath. On the other hand, those roads have existed for hundreds of years and are solid today. It is entirely a question to be studied in the light of local conditions, whether you have got to provide for settlement, or for soft material underneath. And on that basis you have got to decide how thick and what the nature of your foundation has to be. From the little experience I have had it has proven entirely possible that you can have a perfectly satisfactory pavement with moderately heavy traffic on a foundation of rolled macadam, not old material, but material put in place at the time of the paving.

M. F. BRAMLEY (President, Cleveland Trinidad Paving Co.): Mr. Chairman, and Gentlemen: I came here to listen to the many, various and varied speakers who were to address

us today, nearly all having "C. E." after their names. We all know that in business we get some hard, common things knocked into us by reason of hard knocks and hard usage. I rise first to answer the question of the gentleman over here who asked Mr. White how to surface old macadam streets. We surfaced Jackson Boulevard in New York from the cantilever bridge or from the end of the pavement at the end of the cantilever bridge to Flushing Bay, an old macadam street, three years ago. In surfacing that we scarified every inch of it and where the macadam was low—the old macadam—we filled the space with stone about the size of a hickory nut and properly rolled it and the pavement is perfect today, and it is one of the most heavily traveled streets in New York City. We surfaced it with asphalt.

Surfacing with brick is handled a little differently. In Youngstown, Columbus and Cleveland where we surfaced with brick, the brick were properly cleaned, the joints were washed out and dried off and a coat of paint put on and then the surfacing put on top of that. Just as much care must be taken in surfacing old macadam with brick as there must be in surfacing old macadam with asphalt. You must have a true contour, a true shape and a true foundation. If your sand cushion is put in indiscriminately, 3 or 4 ins. thick in one place, and ½ in. in another, and there is less shrinkage away from the brick by reason of the unequal compression brought about, your grout won't hold, your brick will break under the big, heavy trucks, the bricks will get loose, and your entire pavement eventually will shatter.

I am somewhat grieved and surprised at the language used by the last able gentleman who addressed you who evidently is skilled in his vocation in life, and I presume any remarks made here will not be taken as personal, but rather along the line of argument and education. He said he laid streets in Panama without much of a foundation. The discussion here today, as I understand it at the present time, is on matters relative to foundations. We all attend these meetings and we hear various and varied remarks on the surfacing, on the asphalt and the brick; but you never hear much on the foundation of the pavement. Mr. Chairman, and gentlemen, to my mind, the most important problem in building pavements is the foundation.

Now, the gentleman—Mr. MacDonald, I believe—who was pointed out to us as the father of this organization, perhaps by reason of his age and his long experience, remembers some time in his life when an engineer had some power in regulating and building pavements. He echoed that memory

when he said to us here that certain residence streets are paved with business pavement and certain business streets are paved with residence pavement by reason of the pull of some local politician or some one. He also said that he thought this great force here ought to arise, or at least start something, that would bring back to the engineer his own—the right not only to make the plan, but to execute and conclude the plan as the architect does.

I remember away back when we had an engineer in Cleveland whose name was Cyrus Force. He was very active and very aggressive in the preparation of plans, and not only the preparation but he had the right to award the contracts. By reason of his power and his influence and his salary, the newspapers called him "Cyrus the Great." That was a great many years ago.

The whole secret of road building will never be solved; the whole problem of foundation and surface and top and everything else involved in the building of roads and of highways and the building of pavements will never be solved until all municipalities and until all political governing bodies leave to the engineer not only the power to prepare the plan, but the power to see that the plan is executed irrespective of the political gentleman who holds his job. (Applause.)

Now, while the father of this association made that slight remark, he apparently did it with hesitation. Is there any reason, Mr. Chairman, and gentlemen, why there should be any hesitation on that subject? Is there any reason why the engineers in convention assembled, or the road builders, or what not, or whatever you call this body, should fear to take the proper stand in a matter of this kind? The first thing for a concrete foundation or a stone foundation or a foundation for any pavement is a foundation of brains laid with power to execute and build according to well defined theories, and that foundation will never be started, the brain and the intellect will not be stimulated until the position of engineer is recognized above the other fellow, and the salary of the engineer is commensurate with the recognition from the foundation up. That is the first foundation, gentlemen, of a good pavement.

Why should we listen to these able papers? Why should this great convention adjourn itself and not say how thick a foundation should be? One man says it depends on local conditions; a very able gentleman from Massachusetts says in some sections gravel is cheaper and in some sections crushed stone is cheaper, and we must vary the foundation to fit the local conditions. Another gentleman gets up and

sort of hesitatingly says the foundation is governed according to the wishes of the local people adjacent to the highways. I say, with all due respect to the gentleman that made that remark, that the foundation in his mind should first be planned, that he should recommend a proper foundation irrespective of the adjacent farmers on the road and irrespective of the parties who pay the bill. I say to you, Mr. Chairman and gentlemen, that I hope this convention, largely predominated by able engineers, representing the engineers and people of this great country, I say to you before this convention adjourns that I hope, for one contractor, that this great convention or the personnel of its make-up will have sufficient backbone to adopt a standard form of foundation to fit the various and varied conditions in the country and the city. There is absolutely no reason why the wishes of the adjacent farmers or the adjacent taxpayers should be consulted. There is absolutely no reason why the political boss or the ward boss, or the precinct boss should have any hand in saying how thick that foundation should be built.

Now, the able gentleman who read the first paper, Mr. White, said, as I remember, that there are only two classes of foundation, concrete and crushed stone. For the love of Mike, Mr. Chairman, if there are only two classes of foundation, concrete and crushed stone, isn't there sufficient backbone in the personnel of this convention or its engineers who ably represent it, to define how thick that concrete should be and its component parts, and how thick that crushed stone should be and its component parts? It is true we have cities; it is true we have counties in which to build pavements. There is no pavement, however, which is left undisturbed, and there is no pavement that should be built today in my opinion without a concrete foundation. Why, in our city of Cleveland, they dig holes everywhere. Every corporation in the city digs holes when it pleases and where it pleases, and they dump the dirt back in the hole and slop some water over it and you get an order to repair your street under maintenance, and the contractors foot the bills. We thought the county roads leading out through Cuyahoga County—and we have more miles of pavement perhaps than any other county in the country—we thought that they would be exempt from that kind of attack, and now we find that in that great county they have discovered gas, and they run gas pipes along the roads, across the roads, and that in every conceivable direction, and there has been no disturbance of the pavements in any place where the foundation was of

crushed stone or telford, but that every time they disturb the pavement, it is improperly put back and leaves a botch and eye-sore to the public and the public pays the bills.

I am going to try to end my discussion, Mr. Chairman and gentlemen, as quickly as possible, and not bother you further. I presume you all are hungry and some of you were up late last night. Mr. Chairman, I want to say in conclusion simply that this convention of the able men representing the whole country, came here to the great City of Chicago not to simply be on a pleasure jaunt, but they came here representing not only their friends and the people who are interested in this great movement, but the engineers engaged in this construction all over the country. Gentlemen, can't you and won't you stand up here and tell us the character and form of general standard foundations? That is a task. If something else is to follow, that can perhaps take care of itself, but under all pavements of every kind and character, no matter what the brand of brick, no matter what the brand of asphalt, there should be a good solid and substantial foundation.

I thank you. (Applause.)

CHAIRMAN DEAN: Gentlemen, it seems too bad to close this discussion just at this interesting stage, but it is necessary in order to have time to get your luncheon before the afternoon session. There probably may be time later in the day, or tomorrow, to take up the subject where it is now left off. I want to say that the afternoon meeting will be in this same room at 2:30. The meeting now stands adjourned until half-past two.

THIRD SESSION, 2:30 P. M.

CHAIRMAN TILLSON: The first paper scheduled for this afternoon is "Organization of a State Highway Department," by Hon. John N. Carlisle, State Highway Commissioner of New York. (Applause.)

Organization of a State Highway Department

By JOHN N. CARLISLE

State Commissioner of Highways of New York

The first and most important problem in connection with the question of the organization of a state highway department is a study of the amount of work which it will be called upon to do, the extent of the territory which it will have to cover, and the amount of money available for construction and maintenance purposes.

These different phases vary so greatly in the different states that it would be absurd to try and outline an organization that would apply to every state in the Union.

A study of the organization of the department in New York State may assist in the discussion.

Our first roads were built under the direction and control of the State Engineer and Surveyor, an elective officer. In 1909 there was created a commission of three members, appointed by the Governor, for a term of six years each, one member going out every two years. In 1911 this law was repealed and a new commission created, consisting of the State Highway Commissioner, appointed by the Govenor, the State Engineer and Surveyor, elected by the people, and the Superintendent of Public Works, appointed by the Governor.

The theory of this Commission was that all the state work of construction should be collected together under the control of the heads of the different departments doing state construction work.

In 1913 this law was repealed, and the organization of the department was made as follows: A commissioner, appointed for five years, and three deputy commissioners; the first deputy to have charge of the preparation of plans and the construction and building of state and county highways; the second deputy to have charge of the maintenance of the state and county highways, and the third deputy to have charge of the town bureau, having supervision over the balance of the roads in the state known as the town roads.

The law also provided for a secretary and an auditor for the department.

At the main office there is a bureau of tests, having charge of the testing of all materials used upon the roads; an engineer in charge of the preparation of plans for bridges throughout the entire state, and an efficiency engineer charged with collecting data regarding roads both as to cost of maintenance and construction and the tabulating of traffic statistics.

Nine divisions were created in the state, each under the charge of a division engineer who has control of both the construction and the maintenance work in his division.

Under each division engineer is at least one resident engineer and a sufficient number of assistant engineers, levelers, rodmen, chainmen, axemen and inspectors of construction. These are all civil service appointees and the inspectors of construction are required to be residents of the county in which their work is being done. Our maintenance work is

done both by patrolmen and by section gangs under the supervision of civil service employees.

There are already built and constructed in New York State approximately 6,000 miles of state and county highways, and to appreciate the volume of work necessary in connection with the maintenance of these roads alone, it must be understood that these roads, if extended in a single line, would reach from New York to San Francisco; from Montreal, Canada, to Miami, Florida, and there would still be enough mileage left over to duplicate the improved roads of Massachusetts and Connecticut.

In 1914 the department constructed or awarded contracts for a road which would reach from New York to Milwaukee. The total mileage to be constructed is approximately 12,000 miles so that about one-half only of the system has been completed.

In 1913 the payments to contractors for new roads were $12,257,001.93 and this year it will exceed $13,500,000.00. The payrolls during the construction period average about $1,900,000.00 per month and this season over $4,000,000.00 will be expended for maintenance.

No other state will, undoubtedly, ever transact the great volume of work being carried on in New York, and the only object in setting forth the organization and the amount of work done is to bring out the point, that other states with similar territory and very little money available could not possibly support such an organization as does the state of New York.

In addition to the work now intrusted to the present Highway Department of the State of New York, there should also be added the duty of the collection of the automobile tax, which is used entirely for maintenance, and the enforcement of the motor traffic regulation laws.

Taking into consideration the future history of highway construction in the United States, the following duties in my opinion ought to be performed by state highway departments:

1st. Construction of state and county highways paid for in whole or part by the state.

2nd. Maintenance of the same.

3rd. Approval of the location of all roads to be improved by state aid.

4th. Supervision of all town highway work, including the expenditure of all moneys therefor.

5th. Collection of motor license fees and any other fees used for maintenance purposes.

6th. Enforcement of motor traffic regulations.

Organization Suggestions

1. There will always be an argument as to whether the head organization should be a commission composed of several members or a single executive head. My own opinion is that there should be only one commissioner. There is no more reason for three highway commissioners, than there is for three governors or three state engineers.

The head of a highway department, doing a large amount of work, must necessarily be a purely executive, administrative officer, and in a large state like New York it is impossible and it would be impracticable, for a highway commissioner to try and give any attention to engineering details. His time is necessarily spent in looking at the large problems connected with his department; seeing that his force is properly organized and properly working; that the routes of roads are correctly laid out; meeting with delegations from different sections of the state; settling disputes between contractors and localities where roads are being built, and in passing upon final acceptance and payments on the roads. In a small state, where the work is concentrated, a commissioner of highways might properly give attention to engineering details, but in a large state, where his duties are so involved, the head of the department should be an executive, administrative officer only.

2. Under the commissioner should be a sufficient number of deputies to take care of all of the details of the work intrusted to the department. One of the deputies should be designated as chief engineer and should have charge of the details of all the engineering work of the department.

3. There should be a secretary having charge of the correspondence, records, and clerical work and an auditor having charge of the authorization for and the accuracy of every expenditure of state funds.

4. Every state ought to have a bureau of tests where all material to be used in the construction of its roads shall be passed upon by its engineers. In New York State when a road is ready to have plans prepared, an engineer connected with the bureau goes upon the ground and examines all sources of materials and upon his report the division engineer then decides upon the type of the road. All materials of every kind are required to be tested before they are placed and this work can be done more quickly and efficiently than if passed upon in any other way.

5. The state should be divided into a sufficient number of divisions with division engineers in charge, so that the work can be closely supervised on the ground. Under the division

engineers should be such a force of engineers and other employees as may be needed. The entire work of construction and maintenance in each division should be under the division engineer and the entire engineering force should be protected by civil service laws so as to provide for continuous service.

6. A bureau having supervision of all town roads of the state, that is all roads outside of those improved by state aid, should be established. In New York State there are approximately 75,000 miles of road. With the $100,000,000 to be raised by bond issues, only about 10,000 miles will be improved, leaving 65,000 miles to be taken care of by local communities.

To assist the towns in improving this large mileage, the state for years has contributed directly to the towns an amount of money in addition to that raised by the towns locally. This amount is fixed by statute, the amount payable by the state to each town being based upon the assessed valuation per mile and the amount annually raised by the town for highway purposes. The towns have gradually been taking advantage of this act until within the past year the state's share amounted to $1,800,000, and when the towns take full advantage of the act the amount will be $2,199,177 yearly. The amounts asked for by the towns have been constantly increasing year by year, showing that they realize the advantage to be gained by raising the maximum amount in each town in order to obtain the maximum amount of state aid.

The Town Bureau of the State of New York has supervisory power over the expenditure not only of the moneys contributed by the state but also of the moneys raised locally for highway purposes. One of the deputies is in charge of this bureau, and the state is divided into ten districts, with a district supervisor in charge of each, who is required to constantly go about his district and observe the work of the town officials. The law requires that town officials shall keep uniform systems of accounts upon blanks furnished by the department; that written contracts shall be entered into determining the places where and the method in which the highway moneys shall be expended in each town; and copies of these agreements are required to be filed in the department.

A yearly examination of the accounts of each town is made by the district supervisor so that the department will know that the money has been properly expended, and a yearly report is required of each town covering the details of the expenditure of the money.

To properly supervise the expenditure of these moneys the state requires that a certain amount shall be expended each year in each town for permanent types of construction, and is constantly advising the town officials in regard to types of construction of roads, plans for bridges and drainage and culvert structures.

The work of this bureau is not as well understood as some of the other departments of the state, but it is believed that the expenditures of the state's money in this direction and the supervision by the department has resulted in a wonderful improvement in general road conditions throughout the state; and every state ought to make a careful study of the methods adopted in New York State along these lines.

No state highway department will be propeıtly organized if it has jurisdiction over only a few of the roads which are to be improved by state aid. No state can ever bear the burden of improving all of its roads. The most important roads, as in New York, will be built entirely at the expense of the state. The next, or secondary roads, should be built, as in New York, by the state, but with the aid of the counties. To carry out the road problem to its final solution, the balance of the roads must be taken care of, as in New York, by the organization of a town bureau, and giving state aid directly to the towns. Only in this way can the entire system of roads in a state be given the attention which it deserves.

CHAIRMAN TILLSON: The first speaker on the discussion of this paper will be Mr. Paul D. Sargent, Chief Engineer of the Maine State Highway Commission. Mr. Sargent.

PAUL H. SARGENT (Chief Engineer, Maine State Highway Department): I have prepared a short discussion of this subject without seeing Mr. Carlisle's paper and before presenting my prepared discussion there is just one subject suggested by Mr. Carlisle which I would like to touch upon; that is the question of a commission of one or three men.

I have served as a single commissioner for a period of three years; I am now serving as chief engineer under a commission of three men, handling the same work which I formerly did, and a great deal more.

I believe a single commissioner can handle work more expeditiously and, from his own point of view at least, as satisfactorily as it will be handled by a commission of three. From the point of view of the public I believe the three-headed commission has many advantages over the single

commission. The principal advantage, I believe, comes about from the fact that most persons who go to the commission with a complaint, or for a ruling on a certain question, are better satisfied with the judgment of three men than with the judgment of one man. From the same point of view there may be a certain advantage in having a commission of three, particularly when rulings have to be made which at first do not meet popular approval; and occasionally such rulings are necessary. Unless the single commissioner is a man of the highest integrity anl impartiality he might hesitate to make such rulings on account of the criticism by the public, which is sure to follow and which will result in the necessity of more or less explanation in defence of his act, whereas with a commission of three such a responsibility falls much more lightly on each individual.

I believe the best form of commission that can be devised is a non-partisan, non-paid body of three or five men. Membership on a commission under these conditions will attract the highest type of successful business men, who are interested in the welfare of their state and anxious to lend their assistance in promoting such welfare, while the conditions named do not offer the slightest attraction to the average politician who is looking after a job with a stipend.

The organization of a state highway department is in many respects similar to a problem in road improvement. Each is an individual problem depending upon certain conditions and circumstances; consequently, a discussion of this kind can only touch upon the broad general principles which are likely to be met and for which provision must be made.

In the first place, a highway department is organized for the purpose of expending public funds for the improvement of roads, either in general or some specific system. This system may be set forth by the law creating a highway department, or the selection of the system may be a part of the duties of the department itself.

If the system of roads to be improved is left to the selection of the highway department, generally speaking the selection will be much more carefully made than will be the case if the Legislature attends to this duty. This work can probably be best handled by a commission of three or more members, representing as they should the various organizations, or lines of industry directly interested in the question. For example, one member might represent the rural interests, another the industrial life of the state and a third any special interest peculiar to the state. Such a *body* has far better opportunity to make a careful study of the requirements of all classes of road users and all lines of business

directly or indirectly affected by road improvement than a committee of the Legislature which must, of necessity, secure its information in a limited space of time.

If we assume that the highway department is headed by a commission of three or more members it should be the duty of the commission to outline the general business policy of the department and to exercise only in the broadest way a supervisory jurisdiction over its work. The actual execution of the work and handling of the business of the department should be delegated to engineers especially trained in the various lines of work to be undertaken. The proper handling of road improvement contemplates engineering management and supervision of the highest order. There must, of necessity, be surveys, plans, specifications and estimates prior to any construction work. There must be constant supervision during construction, whether the actual work of road improvement be done by contract or on a force account basis. The moment roads are completed the question of maintenance naturally arises. All the way through there is more or less clerical and accounting work.

Naturally, then, it seems as though as simple an organization as can be effected to carry on the work of the ordinary highway department will be a division of surveys and plans; a division of design and construction; a division of maintenance and an accounting division.

The division of surveys and plans should be charged, as the name implies, with the making of surveys and plans and the securing of all preliminary information which will be needed in making an intelligent study of each problem in connection with the improvement of any given section of road. This division should be in charge of an engineer experienced in this particular line of work. He should also be conversant with the different types of road surfaces suitable to carry various classes of traffic, so that he will secure proper information with respect to available materials along any route surveyed which will probably be used in the improvement of the road.

This division, besides making an actual survey of the road and studying available materials, might also be charged with the duty of collecting information with respect to traffic using the road and probable increases or changes in traffic that may be expected after the road is improved. Besides the duties above outlined, it might be well to make it a duty of this division to have charge of staking out all work prior to the actual construction. If this were done it would relieve resident engineers of a considerable amount of work which they now have to do sometimes interfering with proper inspection of work actually under construction. The chief of the division of surveys should prepare instructions

to be followed by field parties in making surveys and recording notes so that all parties will secure the same general information with respect to all roads surveyed, and all notes will be recorded in substantially the same form; this will simplify work in the drafting room and lessen the cost of making plans.

I believe few difficult problems in location are encountered on the majority of roads—especially where the road runs through a well settled country. Accordingly, it is well to have the original survey made as a location survey as far as possible; otherwise, a complete re-survey of the road is advisable, if not necessary, when construction work is begun, especially if the work be done by contract.

The division of design and construction will, of course, be in charge of an engineer, having experience in this particular line of work. This division should digest the information secured by the division of surveys and plans and determine upon the type of surface and all details connected with the construction of each particular section of road. This comprehends the drawing of complete specifications and the preparation of standard designs. This division would naturally make up preliminary estimates of cost of construction, see to advertising work for bids, attend to the letting of contracts and have immediate supervision through resident engineers of the inspection of all construction work, and make estimates for monthly and final payments to contractors, approve force account payments and prepare progress reports of work done.

This division should keep a memoranda of apparent or real discrepancies in specifications or questions relating thereto raised by contractors, if any, during the progress of each season's work in order to avoid a repetition of similar questions in connection with subsequent work.

The division of maintenance, as the name implies, will have charge of all maintenance work. Generally speaking, this is the most difficult and least attractive, but by no means, the least interesting work devolving upon a highway department. The difficulty usually lies in not having adequate funds to properly handle all work needing attention. Poor construction makes expensive maintenance. Changes in traffic before and after the construction of a road sometimes makes necessary maintenance work not even dreamed of when the road was built. The Maintenance Division is expected to cope with all these conditions. To one truly in sympathy with the work these problems are interesting but their solution lacks the glamour and public interest incident to new construction.

This division must be organized so that the entire road mileage shall be kept at as near 100 per cent. efficiency as possible; that is

to say, the roads must be kept practically as good as they were when first finished and accepted by the division of construction. Maintenance is like construction in this respect; the same rule will not apply in every case. Different types of surface demand different attention. Improved earth and gravel surfaces should be maintained by the patrol system. The same system has its place in the maintenance of all types of improved road surfaces. At times maintenance work, especially resurfacing, needs a gang, its size depending on the amount and kind of work to be done. Not infrequently it becomes necessary, on account of increased or changed traffic, to lay a surface entirely different from that originally built. Until the new surface is laid the old must be kept in a satisfactory condition at the least possible cost. Right here the engineer in charge of maintenance may save or waste many times his year's salary, by knowing or not knowing just the right thing to do, and the most economical way to do it. An engineer of wide experience and training and of unusual judgment is needed at the head of this division.

Nothing has been said about an executive officer for a state highway department. Generally speaking this official will be the chief engineer. Besides having a good working knowledge of all lines of engineering coming under his direction he must also be a good executive. He is responsible to the commission, or to the Legislature, if no commission exists, for the proper expenditure of large sums of money. Probably no department in existence spends less than $100,000 per month during the construction season and the expenditure in some departments probably runs as high as $1,000,000 per month.

The chief engineer will have general oversight over all of the department's operations. All divisions of the work will report to him and he alone reports directly to the commission.

The above, with respect to expenditures, shows the necessity for a thoroughly organized and smoothly working accounting division. This division should be able, on short notice, to show gross expenditures of the department, or the expenditure for administration, construction or maintenance or the cost of any particular job at any time. It should be prepared to make prompt payment of estimates or payrolls on force account work, as delays in this respect will certainly result eventually in increased cost of work. Finally, the accounting division should make an easily understandable statement of the department's expeditures to accompany the department's annual report of operations.

No attempt is here made to suggest the number of employes or size of any of the divisions outlined. That will depend entirely on the amount of work to be handled and the territory over which it is spread. In organizing a state highway department the main point to be kept constantly in mind is to know that all work

will be carefully planned and well executed. Good organization and trained supervision in the various divisions of the same will insure this.

Supplementing the organization above outlined would be one wherein the territory over which the Commission had control was divided into several geographical divisions, each division being of such size that the division engineer could cover it for inspection purposes at least once every two weeks. With a considerable volume of work this would be the only practical organization for handling it.

This form of organization undoubtedly has the advantage of securing closer personal supervision of work than that outlined above. Each division engineer ought to be made responsible to the chief engineer for the accuracy of all surveys and for the proper execution of all construction and maintenance work within his division. These men should be of such ability and experience that they would be able to pass on all routine questions arising in connection with all work under their direction. In this way they would very materially relieve the chief engineer and the chiefs of the divisions of construction and maintenance of a considerable amount of inspection and field work, leaving these men more time for general administrative and executive work, which would be necessary in a large organization. A central organization at department headquarters similar to the one already outlined would be necessary to supervise the work of the division engineers.

This scheme of organization is undoubtedly more satisfactory to the executive head and will slightly increase the cost of supervision. As indicated above it is more practicable for departments having large appropriations for expenditure and large quantities of work in progress at the same time.

CHAIRMAN TILLSON: The next speaker on the program for the discussion of this proposition is Mr. S. E. Bradt, Secretary of the Illinois State Highway Commission.

S. E. BRADT (Secretary, Illinois State Highway Commission): Mr. Chairman and Gentlemen: As you probably know, we, in Illinois, for the last two years, have gone through the process of reorganizing the Highway Department under the new law which involved the reorganization of the Highway Department. We have placed at the head of this department three commissioners. I have been greatly interested in the paper of Mr. Carlisle, and so far as I can see there is no chance for any great difference from the discussions that we have just heard. Of course, coming from the state that has a department of three commissioners, we naturally favor three commissioners.

I have taken up this subject, not so much from the standpoint of the paper as discussed by Mr. Carlisle or of the topic discussed by Mr. Carlisle, as perhaps from the standpoint of a state that is just organizing a highway department, or a state like Illinois that is reorganizing its highway department, and so I will just give you briefly the conclusions that we have come to, practically as they have been worked out in this state. As has been stated by Mr. Carlisle, where you have a new state that is organizing a department and the work is not very large, undoubtedly this responsibility could be left with the engineer and avoid the necessity of a commission.

The necessity for highway improvement has forced upon the people the consideration of the best method of conducting this work. It is rapidly coming to be recognized that in order to carry it on efficiently and economically it must be placed under the direction of men who have made a study of road construction, both from the technical and practical standpoint, and who also have the necessary business qualifications. Hence the necessity for a highway department.

In considering the organization of such a department, the question arises as to who shall constitute the head or control of such a department. Shall this control be placed in the hands of one or more representative men and with them a man of technical qualifications to pass upon the engineering questions, or shall we eliminate the commission and place the engineer at the head of the department? The practice thus far favors the placing of this responsibility upon a commission consisting usually of men of affairs. Out of the 41 states having highway departments, 36 states place the authority in the hands of a commission. This policy divides the responsibility and places the deciding of all questions of general policy upon the non-technical men, and the engineering questions upon men especially trained for that purpose.

The questions involved are of such magnitude and affect the people so directly as to render this division of responsibility a very decided advantage.

The practice being in favor of a commission at the head of the organization, a number of other questions immediately arise for discussion, such as, (1.) How many? (2.) How selected? (3.) Term of office? (4.) Paid or non-paid? If paid, how much? (5.) Shall they give their entire time or only a part of it? (6.) What shall be their authority?

These questions are all more or less involved, and hence will be treated somewhat connectedly.

The question of a single commissioner or a commission is possibly the only one concerning which there will be any great difference of opinion or any great amount of discussion.

In the last analysis the success of any undertaking depends upon the man; and we all realize that one man equipped with experience, technical knowledge, good common sense, good judgment of human nature, and all the other necessary qualifications which go to make him a fully rounded man, would get better results than three men, or twenty men, none of whom had these qualifications.

But when you consider that few men have all these necessary qualifications, the average results might be better if you depended on getting all of these qualifications from three men rather than one.

Deciding the questions of general policy, organizing an efficient working department, meeting the state, county and township officials, approving routes, awarding contracts and passing upon work involving millions of dollars, are all questions wherein the judgment of more than one man might be desirable.

As a matter of policy it seems to me that the people of a state will have more confidence in the judgment of three men, as well as in the question of the proper expenditure of the large amounts of money involved.

Again, with a single commissioner, a change might involve an entire change of policy and the placing of new and inexperienced men in all branches of the department—whereas with three commissioners the term of office can be made to expire on different years and the changing of one man will not interfere with the continuity of the work. For these reasons I am inclined to the side of the three commissioners on this much mooted question.

As to the selection, would say that if some practical plan could be devised for appointing a non-partisan commission, it would undoubtedly result in placing a department upon a firmer foundation, and thus prove of great benefit to the road work, but so far no more satisfactory plan has been developed than the appointment of the commission by the state executive.

This method definitely places the responsibility; and this work is of so much importance, is of such a magnitude, and is so close to the entire people of the commonwealth that no administrator can afford to use these appointments for political purposes to the detriment of the efficiency of the department.

Our executives are men of broad experience, are close students of human nature and are in excellent position to select men well fitted for these positions.

Concerning the term of office, I can suggest nothing better than the law which governs in Illinois; viz., a term of six years, that of one commissioner expiring every second year; thus preventing any sudden change in the policy of the department.

The question of a paid or a non-paid commission, and if paid, how much, is one of importance.

It is generally recognized that a man is entitled to compensation for work performed for the state. There are, however, instances wherein the amount of time required is uncertain and where the person in the beginning will be called upon only occasionally and then to act in an advisory capacity where this can be disregarded to the advantage of the state.

In establishing a new state department under such conditions there can usually be found a few men of wide experience who would be willing to give sufficient time for the inaugurating of a new system without compensation. Frequently these are men the value of whose time would be far beyond the small salary which the state would pay.

Therefore in establishing a state highway department the policy of a non-paid commission could be adopted, but when the work increases so as to demand a large part of the time of the commission they should receive proper remuneration. If required to give their entire time, the pay should be sufficient to secure the services of officials capable of carrying on a business expending millions of dollars annually. In many cases a state can secure men of wider experience and of better qualifications by paying a smaller salary and requiring only a part of the time of the commissioners.

It is generally true that men who have been successful in their particular lines of endeavor cannot afford to give up their work entirely. Therefore the requiring of their entire time might eliminate the men we want.

It is recognized that the authority of the commission should include approval of routes, and construction and maintenance of all roads wherein the state contributes a part of the cost.

Doubtless, much of the people's money could be saved by extending the supervision of construction and maintenance to cover all road expenditure throughout the state.

While the work of the commission is of great importance, the most important position in the department is that of the chief engineer. Almost every decision which he is called upon to make affects in some degree the efficiency of the organization and the durability of the work. He should be the actual head of that branch of the department and have control of the entire engineering force. He should be appointed by the commission and should serve during "good behavior." He should not only have the technical qualifications, but should also be a man of experience and good judgment. He should be selected as much upon his record for accomplishment as upon his technical knowledge.

His salary should be determined by the commission and should be sufficient to warrant a thorough preparation on his part, as well as sufficient to retain his services after such preparation has been made.

The further organization of the department as to subdivisions will depend largely upon the scope of the law, under which the department is working.

In many of the states the law is sufficiently broad to require the following divisions:

1. Road division in charge of a road engineer, and under him division engineers, draftsmen and inspectors, as demanded by the work. This division should have charge of maintenance.

2. Bridge division in charge of a bridge engineer, and under him the necessary draftsmen and inspectors for testing road and bridge material. In connection with the road and bridge Divisions, it should be said that whenever they prepare plans and specifications for any work the construction should be carried on under their supervision in order that they may see that specifications are followed, both as to material and workmanship.

3. Laboratory division, for testing all road and bridge materials, in charge of a chief chemist with assistants.

4. Statistical division, for compiling information pertaining to cost of construction and maintenance of each section, amount expended by each county or township, and how expended; source of all road revenues; location, extent and value for road purposes of all road material deposits throughout the state.

This information will be the basis for progress in economy and efficiency and has too often been neglected.

5. Accounting division under a chief clerk, who should have in charge the accounting, blue printing, various blanks and forms, general printing and stationery, and routine correspondence.

6. Editorial division when a publication is issued by a department.

If the state shall have any control or supervision over any of the roads of the state outside of those in which the state contributes a part of the cost, an additional division of the organization should be made to cover this feature of the work.

All members and employees of the department excepting commissioners and chief engineer should be civil service appointees.

In Illinois, we have laid out some 17 per cent., or perhaps 15,000 miles of road connecting all of our county seats, which are known as state aid roads, and that is the system over which the State Highway Commission has jurisdiction. These roads are to be built under its supervision, and are to be paid for, half by the state and half by the counties. Our initial appropriation was very small, only $1,100,000. Of course, the counties provided an equal amount, which brings the appropriation up to over two million dollars, which is to be expended during the biennial period. We didn't get started until the first of July and have expended about one-half of the money. I think that is all I have to say to you. Thank you. (Applause.)

CHAIRMAN TILLSON: The next gentleman on the program is Mr. W. O. Hotchkiss, State Geologist of the Wisconsin Geological and Natural History Survey. He is to discuss this same subject.

W. O. HOTCHKISS (State Geologist of Wisconsin and Secretary of the Wisconsin State Highway Commission): Gentlemen of the American Road Builders' Association: The last man in a discussion of this kind is very fortunate in that he need say very little when the question has been so thoroughly discussed and practically the whole list of ideas possible on the subject has been presented to you in one form or another. So I shall limit myself—with pleasure to myself, and I know to you—with just a couple of thoughts I regard to be fundamental.

A former teacher of mine, the dean of the college where I got my engineering education, used to impress it upon us boys when we came under his supervision in our senior year, that the fundamental maxim of good engineering was to do the best you could with the material at hand, to do no less and *not to do any more;* that to run a survey of five miles of road and close to a hundredth of a foot was nonsense and poor engineering. That illustration will suffice. We have certain conditions of politics, presence or lack of public interest and financial conditions. Our machine should be designed to produce the best work possible under the conditions in which it must work.

Now, there is this fundamental difference between a state highway department and any other engineering organization. The ordinary engineering organization is formed with the idea of accomplishing a particular job for private interests. It doesn't concern such an organization or the members of that organization what the people may think among whom they work. The highway engineer, however, is a public servant. The highway engineer—as I have told the men in our department many times—who goes out and builds a good road and leaves the people of the locality thinking that he has done wrong, that he has built too expensive a road, that he has built it too well for the circumstances or thinking that he is arbitrary and unwilling to listen to reason, or anything of the sort, has done a poorer piece of engineering, from the standpoint of a state highway department, than the man who goes out and builds a moderately good road and builds it in such a way that the local people appreciate what has been done and are in a frame of mind willing to go ahead. Now, there is what I believe to be a very important fundamental difference between the service in a state highway department and the service in the engineering department of a railway, for instance. I do not

think that we who have to do with the organization of state highway departments can lay too much stress upon that feature. There must be instilled into the mind of every member of the department--if it is possible to do so—the idea that he shall not merely be a road builder, but that he shall be an educator of the public to the value of good roads and to the knowledge of the needs of good roads and what they should be. In so far as the organization of a state highway department accomplishes that will its success be secure and permanent.

There is one other point that has been touched upon, about which I can speak with experience, and that is the matter of the commission. I was introduced as the State Geologist of Wisconsin. By virtue of that office I am a member of the State Highway Commission of Wisconsin. Our commission is composed of three members, appointed by the Governor for terms of six years each, their terms expiring each two years. That is, one man goes out every two years. In addition to the three appointed members there are two ex-officio members, the Dean of the Engineering College of the State University, and the State Geologist. It might perhaps seem a strange thing to put a geologist in this work but it so happens that the man who was in that position started the highway work in Wisconsin. So it was perhaps a little in the nature of a special case, and it was thought the part of wisdom to keep what little experience the State Geologist might have connected with the Highway Commission. I had charge of that work for four years, and I gave practically my whole time to the work during that time. I know the great advantage of the single executive for all executive work; there is absolutely no question of it in my mind, nor, I believe, in the mind of any other man who has had any experience in executive work. When you come to deliberation, to matters of policy, you have another matter entirely, and if you will stop to think of the organization of our various governmental departments, you will find that the most successful ones are organized on these two principles—several heads for counsel, one head for execution. We have one governor and several justices on the supreme bench; one general manager and several men as a board of directors. If you can divide the responsibility for the conduct of a state highway department in that fashion, I believe you will have the best possible beginning for a state highway department. I think the matter of three or five commissioners is largely a matter of choice. I don't think there is much importance to be attached to a discussion of that point.

The commission in Wisconsin, I may say, serves entirely without salary. I have taken occasion to discuss this salary matter with a great many public men and with a great many private men,

and I find this as the result of my inquiry: (Perhaps it is because I have looked for it, because I earnestly believe it myself, and perhaps it is because there is truth in it, and I leave you to judge as each of you shall see fit.) I have found that upon serious conversation with men of large private affairs the feelings on the part of many of them, that they are willing and glad to give a moderate amount of their time to an enterprise for the benefit of the public. We see that constantly in bequests for charitable and for educational purposes. Those men who give thus are men of broad experience in business lines, men of the broadest experience of any men that we have, men of the type who serve upon various public boards, and more often upon various private boards, such as managers of our endowed and state colleges and that sort of thing. Now, there is the feeling on the part of those men that they are willing to give a moderate amount of time from their business providing that they can feel that they are engaged in a thing conducted for the benefit of the public. I believe most earnestly that the best form of commission that it is possible to get—if your executive who appoints them is right—is a commission composed of such men of large affairs, who will meet not too frequently. The matters that come up before the state highway department are routine for the large part and should be looked after by the paid executive officer. The commission can meet once a month for a day and determine all matters of principle that ordinarily come up and matters of organization in the department. You can get service of the highest quality, if you demand it, of such men as a contribution to the public welfare. I found that idea in the minds of many men of large affairs. That the state can command, *without* salary, the services of better men than she can *with* salary for such part time public service, is almost word for word the expression of a very well-known United States senator who is now dead. I believe it most firmly. In studying this matter, and in going over all these things, there is no one thing that I believe to be more important for the ultimate and continued success of a highway department than to get behind it the public-spirited interest of the best and most capable citizens of the commonwealth and the state. No state, I believe, can command the services of those men for salaries.

Gentlemen, I thank you. (Applause.)

CHAIRMAN TILLSON: This completes the list of speakers on the program on this subject. As we have two more subjects this afternoon, and the day is getting on, I think it would be

advisable to go on with the next subject. Then if we have time after the completion of the next two, we can discuss any of the three that are on the program for the afternoon. The next paper is "Traffic; Present Tendencies, Probable Development, and Regulation," by Mr. A. W. Dean, Chief Engineer of the Massachusetts Highway Commission. You were looking at Mr. Dean all the forenoon, so you will all recognize him when he comes to the front. (Applause.)

Traffic; Present Tendencies, Probable Development and Regulation

By A. W. DEAN
Chief Engineer of the Massachusetts Highway Commission

A quarter of a century ago bicycle riding became a popular means of securing exercise and pleasure, and the riders became so numerous that a great impetus was given to the previously dormant interest in roads. Agitation started at that time brought about a considerable amount of road improvement, sufficient to show to the users of horse-drawn vehicles that a good road was beneficial not only for the pleasure of the cyclist, but for the business of the team owners, consequently there was an added interest in road improvement, and when motor vehicles came into general use this interest was, of course, several times compounded. The desire and necessity for good and permanent roadways is bound to increase in the future, not particularly to furnish pleasure to the automobile enthusiasts, but also to facilitate the movement of commerce between neighboring points.

The number of horse-drawn vehicles using the highways is not materially changing, while the number of motor vehicles is increasing greatly.

Proof of this is shown by comparing two traffic censuses taken by the Massachusetts Highway Commission at intervals three years apart. Adding the traffic of two dozen stations selected at random, it is found that in three years the number of horse-drawn vehicles passing these stations decreased in three years from 4,547 to 4,455, or about 2 per cent., while the number of motor-driven vehicles increased from 3,708 to 11,198, more than threefold. The period covered by the foregoing was between the years 1909 and 1912, and it may be fairly assumed that the proportion of change since 1912 has been similar. This assumption is borne out by a comparison of the number of motor vehicle registrations made each year, table of which is here given.

STATEMENT SHOWING THE NUMBER OF MOTOR CARS REGISTERED, 1906 TO 1914, MASSACHUSETTS HIGHWAY COMMISSION.

	1906	1907	1908	1909	1910	1911	1912	1913	1914
Automobiles (pleasure) ..	6572	7733	18066	23011	29792	36284	46096	56712	68100
Dealers' Automobiles	755	455	1905	2455	3305	4920	6301	7462	7898
Trucks	....	....	....	960	1568	2623	4036	5948	8053
	7327	8188	19971	26426	34665	43827	56433	70122	84051

It does not appear to be necessary to add anything to the foregoing to show clearly the present tendency of traffic so far as relates to type and quantity, except to express the opinion that in large cities the increase in motor-driven vehicles may be somewhat greater.

The table shows the increase in numbers of motor trucks to be in large proportion annually, and it may be expected that with the improvement in development of the machinery and the increased use found for motor trucks, the percentage of motor trucks as compared with that of other motor vehicles will increase rapidly. The capacity in tons of motor trucks is being increased annually, so that at the present time it is no unusual thing to have a truck, including its load, weighing 10 tons or more, passing over the highways and bridges. In the vicinity of the docks in Liverpool loaded vehicles weighing 30 tons are not unusual. This probable development in motor truck traffic cannot be and should not be prevented, except within certain limits. Many bridges are not of sufficient strength to carry safely even a 10-ton load, consequently, there should be a restriction in the weight of vehicles, and there should also be requirements fixing the minimum loading for which new bridges should be designed. Building laws in many cities and towns require that when a building is altered or constructed, it shall conform with certain requirements. A similar law should be passed in relation to bridges in order to permit the use of heavier vehicles than can now be safely used. Emphasis need not be placed on the fact that the roadways constructed hereafter should be designed with sufficient strength and proper material to withstand the heavier loads. On the other hand, unless some restriction is placed upon the weights of loads that are to be permitted to be carried over the highways and bridges, there will be a tendency to develop excessively heavy trucks such as are used, as already mentioned, in Liverpool. The Legislature of Massachusetts in 1913 anticipated the necessity for regulating the weight of traffic and passed an act, a portion of which reads as follows:

No traction engine, trailer, motor or other vehicle shall be operated upon or over a highway or bridge in any city or town in this commonwealth, nor shall any object be moved over or upon any such highway or bridge, upon wheels, rollers or otherwise, in excess of a total weight of fourteen tons, including vehicle, object or contrivance and load, without first obtaining the permit mentioned in section three of this act from the authority or authorities therein mentioned; nor shall any vehicle be operated or contrivance moved upon or over said highways or bridges which has any flange, ribs, clamps or other object attached to its wheels or made a part thereof, which will injure, cut into or destroy the surface of the highway or bridge for any considerable depth; and in the towns of the commonwealth outside of the metropolitan parks or sewerage districts no such engine, vehicle, object or contrivance for moving heavy loads shall be operated or moved upon or over any such highway or bridge the weight of which resting upon the surface of said highway or bridge exceeds eight hundred pounds upon any inch in width of the tire, roller, wheel or other object, without first obtaining said permit, unless such highway or bridge is paved with brick, block, sheet asphalt, concrete pavement or surface. The owner, driver, operator, or mover of any such engine, vehicle, object or contrivance over said highway or bridge shall, unless relieved from liability in said permit, be responsible for all damages which said highway or bridge may sustain as a result of said action on his part, and the amount thereof may be recovered in an action of tort by the authority or authorities in charge of the maintenance or care of said highway or bridge, or by the authorities of the town, the Massachusetts Highway Commission, or the County Commissioners which have charge of the highway or bridge which is injured.

No steam traction engine, with or without trailers, and no motor truck carrying a weight in excess of four tons, including the vehicle, shall be operated upon any highway or bridge in this commonwealth at a speed greater than fifteen miles an hour; and no such vehicle carrying a weight in excess of six tons, including the vehicle, shall be operated upon any such highway or bridge at a speed greater than six miles an hour when such vehicle is equipped with iron or steel tires, nor greater than twelve miles an hour when the vehicle is equipped with tires of hard rubber or other similar substance.

The remainder of the act provides that the authorities having control over any road may grant permits for moving vehicles weighing more than fourteen tons, but when such permit is granted, it is provided that the person to whom permit is issued shall be responsible for any damage that may be done to highways or bridges. The act also provides a fine of $100 for each and every offence. While this act may not be perfect, it is of great assistance in regulating traffic of heavy vehicles, and is here given as a recommendation for general adoption.

CHAIRMAN TILLSON: The next name on the program for the discussion of this paper is Mr. A. N. Johnson, of the Bureau

of Municipal Research, of New York City. Is Mr. Johnson present?

The name following him is Mr. W. H. Messinger, Assistant Engineer of the Bureau of Highways, Borough of Brooklyn, New York City. Is Mr. Messinger present?

The next name is Mr. C. A. Kenyon. Mr. Kenyon is the President of the Indiana Good Roads Association and will address you on this subject. (Applause.)

MR. KENYON (President, Indiana Good Roads Association): Mr. Chairman and Gentlemen: You have a lot of speeches, and I am not going to detain you long even though this is a very important subject. I have made a few notes here, and I want to read them in order to expedite the discussion. You have another subject to discuss and it is getting late. I have often thought: Is it not a bit odd that the public for a long time has been very much interested and concerned in public health? Almost every state and city has a health board and a constant campaign is being waged against all forms of disease, from pellagra to tuberculosis, but why is it that in this campaign the great number of deaths and injuries caused by what are called accidents, have little place? We had over 5,000 injuries last year on our highways—injuries and deaths—and Illinois, Indiana, New York and one other state were the four that had the most. We don't seem to be paying very much attention to it. The boards of health, be they state or city, have not made and are not making, as a rule, any aggressive move in this most important question. Manufacturers, labor organizations and others are at work, and the National Council for Industrial Safety is doing splendid work. But most of this is quite recent. and again, most of it is in connection with railroads and industrial concerns in their "safety first" campaigns.

Is it because the public doesn't like to charge itself with any fault in this matter? We take some pleasure in charging railroad managers, manufacturers and others with wanton destruction of human life and are willing to pass all sorts of laws to curb, punish and regulate, but when it comes to putting any such regulations on the general public for its own good, it is a wanton interference with personal liberty. So many people say, "Well. another law against the people's right," and so on. Necessity has driven us to have some sort of traffic regulations and traffic officers in the cities, but how difficult it is to enforce the laws. Every one seems to feel at liberty to disregard them whenever he thinks he can do so with impunity. As for the country highways, the country people swear at the city speeders, and the tourist often thinks that the country people are malicious; and accidents and deaths go on all the time.

Just to illustrate, to bring to your mind a thought. You have a traffic policeman at the corner. He exercises a restraining influence with his whistle or his club in holding people back and letting the traffic pass. You would think that after a while the people would get used to that and that they would naturally get so that they would do it themselves, of their own account. But let that policeman go away any time during the day for half an hour, and then look at that same corner, and you see what I call that disregard of authority.

In 1913 there were 1,125 killed and 3,080 injured at grade crossings alone. The statistics of the other accidents on the highways are not generally collected as far as I am informed, and yet we know that they amount up into the thousands. Now, why is this? Is it not that there is no state organizations or officials whose duty it is to gather statistics and make reports or perfect a "safety first" organization for the benefit of the public? And probably if any one proposed it, some one would jump up and say that it was only another scheme to increase the taxes. What are you going to do about it? For my own self I am going to say that every state highway department should have a public safety department to deal with this question. To accomplish results, you must have a working organization and a systematic plan and direction and supervision.

To my mind it divides itself something in this fashion; I would say into two elements: First, the personal; and, second, the mechanical. Each is important enough considering the number of accidents and deaths, to have a separate director. Probably one would be sufficient, however. The personal element is largely educational. The people must be taught to be careful and not to be offended by the suggestion that in a large measure they cause accidents by being careless and relying on the other fellow to protect them.

I was in London last year, and there they had very careful supervision with their excellent "bobby" force—a great number of their crossing policemen to protect the public. But there had been so many accidents and deaths that Parliament appointed a commission to investigate the subject. They reported while I was there, and there was a wide discussion of it. In the city of London 125,000 people had been killed or injured in the last eight years. Think of it! What a toll of death that is, 125.000, where they had all these refuges in the middle of the street and the policemen on the corner, and so on. What did that investigation show? A very large percentage of the accidents were caused by the people running across the streets, running in front of vehicles, running behind one only to be caught by another, and all those various forms of accidents

that you are acquainted with that I am not going to take the time to discuss. I will say a word more a little bit later about what they found in regard to the matter of regulation.

But to go on. It is the same with us. To take a chance seems to be a national characteristic. It is almost always said that the reason for being hurt was because the driver was careless or he was a speed maniac—never the carelessness of the individual that gets hurt. In Paris they have a regulation that if a man gets hurt, they arrest the man that gets hurt out in the roadway. Here they always arrest the driver. They take it for granted that the man was, of course, not to blame; the driver was to blame. A Parisian said to me, "Doesn't it seem a bit strange to you Americans, who look at it possibly in a different light from us, that you should lay so much responsibility on a driver, maybe of an omnibus, who has himself and three big horses to look after and control, and then the lives of twenty people, perhaps, on the inside, whom it is his duty to look after? He has all those responsibilities. He is a mere driver. Here is an individual crossing the street; he has no one but himself; he is unhampered with any responsibility like three big brutes to look after or the lives of twenty people in his keeping. And yet you Americans want to charge that driver with the responsibility for hurting an individual who has no one else to look after but himself." We have that idea. People say, "Oh, we must allow personal liberty." Personal liberty all the time. But when they put that regulation into force in Paris, they cut down the number of accidents in the city of Paris over 40 per cent. within the first year. Parisians are not allowed to cross the street without violating the law and being arrested, except at street crossings where there is a policeman to protect them. They can't run across the street wherever they desire without being punished for it. Now they have less than 50 per cent. of the accidents that they previously had.

Why not some official then, or department, to study the hazards of the road, to formulate traffic regulations along the line Mr. Dean advocated, recommend safety appliances, educate the public by distributing bulletins, getting the schools to teach safety first slogans, have road bulletin boards along the congested places, where people who don't go to school can read those bulletins and get an idea that they must be careful? They do that in England. Every underground station, every 'bus and so on has a big sign with a lot of slogans on it and a picture showing the way to get off a tramcar or an omnibus, and the way to avoid traffic in the streets, with pictures showing how people are being injured in the streets—all such things as that being

carried on all the time. Yet for some reason or another we take little notice of it. We have no one to direct it.

That is the point I am trying to make here. There is no one to send out these road bulletins, to enforce safety rules, to report accidents, and make recommendations and perfect organization. That is on the educational side, that is on the personal side.

Second, we have the mechanical side. This involves a study of the hazards incident to roads and bridges, planning construction, safeguarding. When the proper safeguarding means have been worked out and installed, they must be used and maintained, and to make these really serve the purpose there must be inspection and enforcement. It doesn't do any good to have an appliance, a method of safeguarding, unless it is used. You put a pole down in front of a railroad train or at a crossing, and unless someone is there to put it down and take it up when the traffic is going along, what is the use of installing it? They must be used and maintained.

With a properly skilled organization or office whose duty it is to do this thing, many dangerous grade crossings could be eliminated, obstructions to a clear view could be removed, dangerous curves and corners could be protected or corrected, needed guard rails installed, unsafe bridges, culverts and embankments repaired—all reducing deaths and injuries to ourselves, the public. But if it is nobody's duty to do these things, or only one of ninety-nine other duties, you may be sure it will not be done in a general and systematic way and the havoc of the grim reaper will go on until the public becomes more civilized.

I thank you, gentlemen. (Applause.)

CHAIRMAN TILLSON: The next gentleman to discuss this subject is Mr. W. W. Marr, Consulting Engineer of the Sheridan Road Improvement Association. Is Mr. Marr here?

If not, we will proceed to the next subject, "Machinery for Construction and Maintenance—State, Municipal, Contractors, Traction Haulage of Stone, Care of Machinery—Instructions to Engineers and Operator," by Mr. T. R. Agg, Professor of Highway Engineering, Iowa State College. Mr. Agg.

T. R. AGG (Professor of Highway Engineering, Iowa State College): Gentlemen of the American Good Roads Congress: The topic that has been assigned to me covers the entire range of the selection and operation of road building machinery, entirely too wide a subject for me to discuss in its entirety. I have attempted only to open the discussion on this very important phase of road building activity.

Machinery for Construction and Maintenance—State, Municipal, Contractors, Traction Haulage of Stone, Care of Machinery—Instructions to Engineer and Operator.

By T. R. AGG
Professor of Highway Engineering, Iowa State College

The wide range of machinery and appliances available for road and pavement construction makes advisable a careful selection for any particular class of work and yet many types of machinery are so much alike in general design that a selection must be based on a careful study of their operating characteristics. Probably there is no one best type for any given set of conditions nor any one best make of a given type, as a general rule. It is not within the scope of this paper to discuss the many kinds and varieties of good, bad and indifferent road building machinery, but it is proposed to discuss a few principles applicable to its selection, operation and maintenance.

Selection of Type of Machine

We find a group of machines available for earth road work, another for macadam construction, and so on through the various classes. These groups overlap to some extent.

Of the machinery offered for earth road work certain types such as the leveler are for a rather limited kind of work while others, such as the blade grader and elevating grader, are for more diverse uses. When a selection is to be made for a special work for which only one class of machine is made, one has only to choose the best bargains from the limited offerings of the class. But when machinery is to be chosen for more diverse uses, operating characteristics and adaptability must be considered. It will usually be found that the selection may be narrowed down to two or three makes and the final choice will depend upon price and personal preference.

The leveler has already been mentioned as an example of a specialized machine, and the mixer for concrete pavement construction is another. For this work it seems to be agreed that the traction type with boom delivery is the best. Of these, several makes are available and which to select will depend upon the purchaser's opinion as to the value and suitability of individual machines.

On the other hand the choice for earth road construction will be between the elevating grader and the blade grader and between traction haulage and team haulage and between the steam tractor and the gas tractor. Here the purchaser must decide between the classes first of all, and then between individual makes of the class.

This is typical of the machinery available for many classes of road work and the basis for a proper comparison is not easy to state. It is believed, however, that the following factors must be taken into account: (a) purchase price, (b) rate of depreciation, (c) maintenance cost, (d) cost of operation and (e) speed, all of which enter into the cost of doing work with any piece of machinery.

To properly estimate these factors there are at present but incomplete and contradictory cost data available and engineers and contractors can do a great service by giving publicity to any reliable and conclusive cost data that comes into their hands.

Purchase Price.—Some kinds of machinery will save their cost in comparatively short time and such may unhesitatingly be chosen because the user can readily foretell whether he has enough work ahead to make the investment profitable. Other kinds require a large outlay and must be used with reasonable regularity for a term of years before they will prove profitable. Eventually, if they can be kept busy they will pay; but before such machinery is purchased, there must be some assurance that the necessary work can be secured. It would often be cheaper in the long run to use a machine which operated at a higher unit cost, but which could be purchased at a much lower price.

Depreciation.—Depreciation is probably the most difficult factor to estimate because the carefulness of the operator has such a marked influence on the life of a machine. With most machinery the average life is fairly well established and hence depreciation can easily be estimated. This is a very important cost item and is probably more often placed too low rather than too high.

Maintenance.—The influence of maintenance on unit costs is well understood, and needs no special comment. Probably this item is also more often underestimated than overestimated. It should be borne in mind that maintenance cost really includes not only the charge for making repairs to a machine but also the cost of delay due to the idle time of the machine. When a large gang is working around a machine such as a concrete mixer any delay on account of the machine is expensive.

Cost of Operation.—The cost of operation for a machine should be taken from the average of many runs under normal conditions and not from exceptional runs made under the most favorable conditions. This cost will include the pay of all men needed to run the machine and the cost of all supplies regularly used in its operation.

Speed.—The rapidity with which a machine performs its work is a very important consideration not only from the standpoint of cost per unit of work done but from the impetus it gives to the entire job. This is particularly true in road and pavement construction where favorable weather conditions must be utilized.

Skill Required to Operate.—The skill required to operate a particular machine should be given consideration because expert operators are not always easily obtained and if a machine requires considerable skill in operation to produce the maximum output, its average may be low due to the difficulty of securing and retaining expert operators. Such machinery should usually be purchased only because of its marked superiority in other respects.

Adaptability.—Adaptability of a machine to various classes of work is an important consideration because it is rarely possible to foretell just where it will be used next and it is better to use a reasonably efficient machine continuously than it is to use a special and highly efficient machine for a certain kind of work and have it idle a large percentage of the time.

Having estimated as accurately as possible the various factors enumerated as above, preference should be given to the one type showing up the best.

The adoption of certain types of machinery for various classes of road work has been largely a survival of the fittest although on account of the new types that are continually being marketed, the process of weeding out is going on constantly. For most classes of highway work the preferred types are fairly well known and to enumerate them here would serve no useful purpose.

In rural communities, labor is usually scarce and the contractor in highway construction will find it to his advantage to utilize every machine that will facilitate his work even though it may not in all cases reduce his unit costs. In the long run, he will profit because of a greatly increased yardage for his season's output.

Methods of Hauling Road Materials

Those engaged in constructing roads and pavements have long realized what a large item of cost is incurred in hauling materials, and some discussion of the methods available is pertinent to this paper. Many factors involved in determining the cost of hauling are variable for work in different localities but for a given piece of work the amount of each of these can usually be selected with reasonable accuracy, and the economy of various methods thus compared.

The cost of hauling varies with the following factors:

1. Length of haul.

2. Rate of travel of the outfit used.
3. Amount of time lost at cars while loading and at road while unloading.
4. Amount of time lost on account of bad roads.
5. Capacity of the outfit per trip.
6. Cost of operation of the outfit.

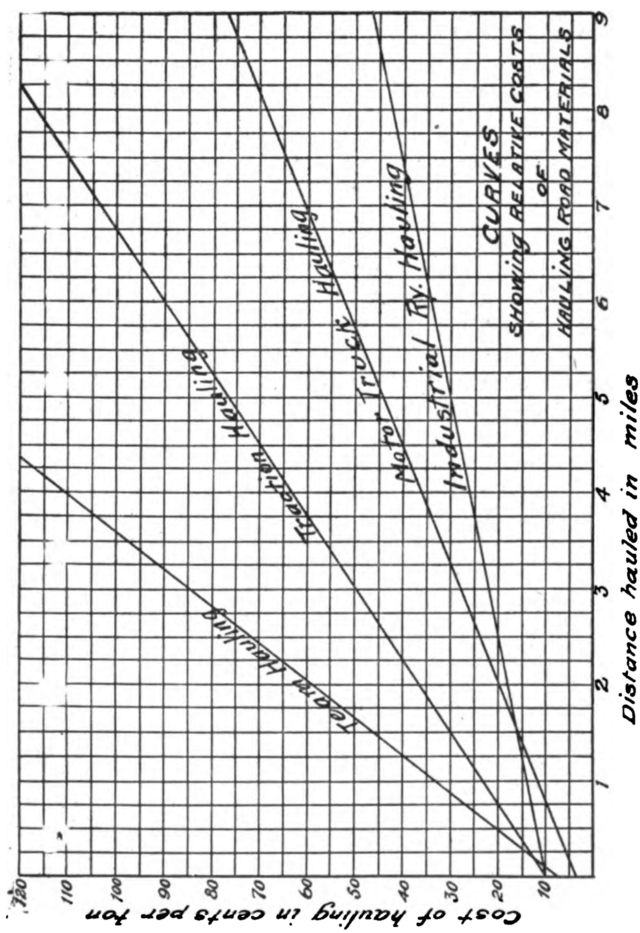


FIGURE NO. 1. CURVES SHOWING RELATIVE COSTS OF HAULING ROAD MATERIALS.

Length of Haul.—Length of haul for a given piece of work is, of course, the same no matter what method of hauling is used.

Rate of Travel.—The rate of travel varies somewhat be-

tween outfits of the same kind and yet there is a value that is reasonably near an average for all outfits of a type. For teams 2½ miles per hour, traction outfits 3 miles per hour, motor trucks 10 miles per hour, and for the industrial railway 10 miles per hour may be taken as typical speeds, assuming half the distance is traveled empty and half loaded.

Lost Time.—The amount of time lost at cars depends upon the method of loading the outfit. If hand shoveling is resorted to the time will be relatively long but extra units of the outfit may be loaded while the others are on the road. This is advisable for all classes of hauling outfits and is a necessity in traction hauling and with the industrial railway. Bins at the sidings with capacity for a full load for the outfit may be used instead of extra units of equipment and are a necessity when the motor truck is used. For team hauling the loading chute may be employed instead of extra wagons. In any case time lost at the cars is expensive, especially on short hauls, and should be eliminated as far as possible.

Records of loss of time in loading and in unloading are exceedingly diverse, but the following amounts lost per trip are near enough the average to give comparable results: With team hauling 18 minutes, motor trucks (loaded from bins or hoppers), 6 minutes, traction outfits, 30 minutes, and with the industrial railway, 30 minutes.

Time lost due to the condition of the road cannot be evaluated in a discussion like this because it varies throughout the season, differs with the locality and with the kinds of roads over which the hauling must be done. It is the greatest with the traction outfit, is about the same for team and motor truck hauling and is a negligible factor for the industrial railway.

The capacities of these outfits per trip are also exceedingly diverse and perhaps no particular one is typical, but equipment of the following capacities are in common use and will serve as examples: Wagons for team hauling, 2 tons; motor trucks, 5 tons; traction outfits, 15 tons; industrial railway trains, 20 tons.

The cost of operation of each of these outfits will vary with the skill of the superintendent, the character of the operator, the kind of weather encountered and the nature of the road that is used. Cost of operation should include the following items: Interest on investment; depreciation on outfit; maintenance of outfit; fuel, oil and other supplies used, and labor const of operation. These various items must be evaluated in estimating the cost per hour for operation, and a careful study of the subject has led to the assignment of the following values: Cost of operation per hour for teams

$0.50, for motor truck $2.00, for traction outfit $3.00, for industrial railway $4.00. If any inequalities exist here they will of course change the entire relation, but the method of comparing costs of hauling as outlined is applicable and that is the principal object of this discussion.

Knowing the relation that exists between these various factors that enter into cost of hauling an equation may be written to show the cost per ton which is as follows:

$$C = \frac{rd}{us} + \frac{Tr}{u}$$

where

C=cost per ton for a length of haul$=\frac{d}{2}$

d=distance in miles traveled per round trip.
u=number of tons hauled per trip.
s=speed of vehicle in miles per hour.
T=time lost loading plus time lost unloading.
r=cost of operation in dollars per hour.

If, in the general expression given above, we insert the values of the various factors for each method of hauling we get the unit cost of hauling by that method for any length of haul$\frac{d}{2}$.

These are as follows:

$C=0.1\,d+0.075$, for team hauling.
$C=0.04\,d+0.04$, for motor truck hauling.
$C=0.666d+0.10$, for traction hauling.
$C=0.02\,d+0.10$, for industrial railway hauling.

For convenience of comparison the unit costs for various lengths of haul have been computed and the diagrams in Figure No. 1 constructed. It is easy to see at a glance the most economical method for any length of haul. If the assumed values of the various factors are in any case inapplicable to a given set of conditions the proper ones may be selected and similar curves drawn for use in comparing the costs for these conditions.

It is also convenient to know the capacity of these various outfits per working day and the diagrams in Figure No. 2 have been drawn to show the amount of material each outfit will deliver per hour and per day when working under the assumed conditions.

The important thing in this discussion is not the relative costs shown by these diagrams but the possibility of reducing to definite data the probable costs for any piece of work,

thus obtaining a basis for determining which method to use. In all of this discussion one factor has of necessity been omitted which is of greater importance than any other and that is the personality of the superintendent. One man fails to make certain equipment pay out and another succeeds in

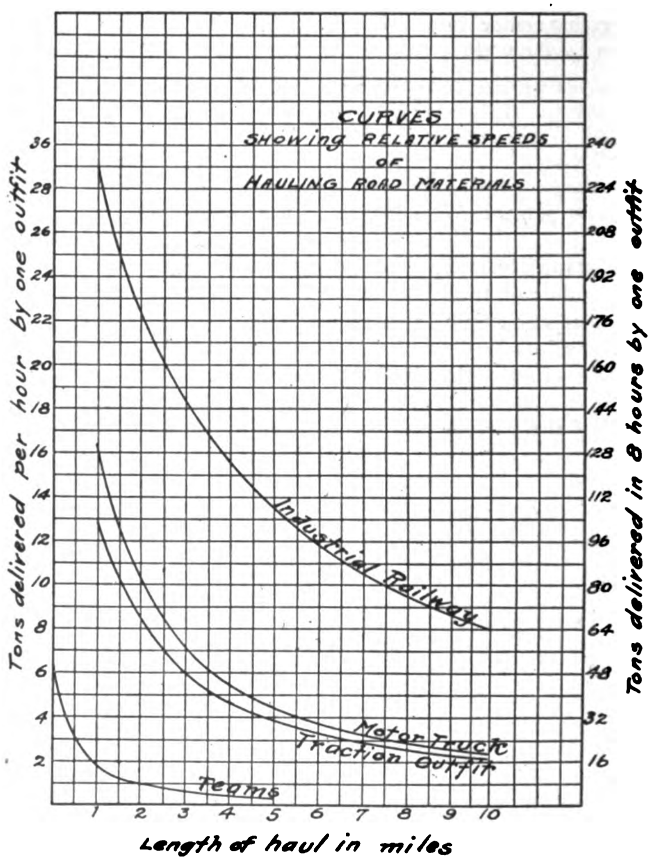


FIGURE NO. 2—RELATIVE HAULING SPEEDS.

accomplishing remarkable results with it. Two sets of cost data are obtained, the one showing abnormally high costs, the other showing costs that are exceedingly low. No general discussion can ignore these facts but they cannot be put into data for use in average cases.

Instruction to Engineers

States, municipalities and a few construction companies seek to insure that no engineer in their employ will allow the

organization of which he is superintendent to fall below the average in efficiency. To that end instructions regarding the use and capacity of various kinds of machinery and as to methods of organization are furnished. Some of these manuals of instruction are excellent treatises on highway construction. Three phases of the use of machinery are usually presented and these cover the normal requirements of such instruction.

The general organization of the work is first outlined. Ordinarily some one machine or operation is the pacemaker for the whole job and when that is true the engineer in charge of construction must build up his whole organization about that machine or operation. The instructions can outline a workable organization but the live engineer will usually be able to improve upon the details.

The instructions next deal with the capacities of machines, rate of construction that can be attained and quality of work that should result. Such matter serves admirably as a yard stick by which the engineer may measure his efficiency. Here again, a man's personality will often enable him to do much better than the average set down in the instructions.

And finally the instructions deal with reports, cost data and records of progress that are required. In this respect the instructions will be specific and lay down exact requirements. Instructions to engineers are not, nor can they be, a series of exact rules that must be followed, because no one can foresee all phases of the multitude of detail that enters into the prosecution of construction work and competent engineers would be hampered by instructions that attempted to prescribe exactly how each machine should be utilized.

Instruction to Operators

In the widespread use of costly machinery there always lies the danger of loss through incompetent operation. Delays due to breakdowns are costly and often avoidable. Here again many states and municipal organizations seek to avoid trouble by furnishing to machine operators complete instructions.

These instructions deal first of all with the operation of the machine and since the work is largely mechanical though skilled, the instructions can say in detail just how the machine is to be handled. Here minute instructions are justifiable and they would include besides suggestions on operations, others on the care of the machine, the making of repairs, methods of adjustments and renewals of working parts. The matter of personal conduct should also be dealt

with in these instructions since the public often obtains its impressions of a department by the conduct of some irresponsible subordinate.

The construction of highways involves the handling of much bulky material and consideration of efficiency and economy requires that the machinery shall be well adapted to the work for which it is used, that the operations be systematized so that each machine will produce to capacity, that the machinery shall be handled in an intelligent manner so as to have normal life, and that the problem of transportation be studied in all its relations before a system is adopted.

CHAIRMAN TILLSON: The next name on the program is of Mr. R. C. Watts, in charge of equipment, Ohio State Highway Department. Is Mr. Watts present?

The next man is Mr. F. L. Cranford, Road Contractor, Brooklyn, New York. Is Mr. Cranford present?

Mr. Ransome Rowe, Contractor, Boston, Mass., is the next man. Is Mr. Rowe present?

Mr. Thomas H. Gill, Binghamton, N. Y., is next. Is Mr. Gill present?

Mr. Joseph Walker, President of the J. Walker Construction Company, Albany, N. Y. Is Mr. Walker present?

There doesn't seem to be any more we can get to present discussions on this subject, but before any one goes out I want to call your attention to the banquet that is to be given at the Hotel La Salle this evening at seven o'clock. The tickets, if there are those who have not obtained them, can be obtained down in the arena at the registration booth, or at the hotel, for three dollars each.

Now, all of these papers, the three papers that have been presented, are open for general discussion. Has any one anything to say on these papers? If so, we will be glad to hear from him. If there is no discussion on any of these papers, we will proceed with the business meeting of the Association, to which attention was called by Mr. Dean this morning. Of course all matters that come up at this meeting will be voted upon only by those who are members. Has any one anything to present at the business meeting?

Business Meeting

MR. DEAN: Mr. Chairman, in past years it has been the custom to appoint a nominating committee on the last day of the convention. This has caused a great deal of difficulty for the nominating committee, in that it had to do a great deal of its business by correspondence. Therefore, I recommend that a nomi-

nating committee be appointed at this time instead of on the last day of the meeting, and I nominate the following gentlemen: Mr. R. A. Meeker, New Jersey; Mr. F. E. Ellis, Massachusetts; Mr. C. A. Kenyon, Indiana; Mr. W. G. Leininger, Illinois; Mr. G. A. Nelson, Alabama; Mr. W. S. Gearhart, Kansas; Mr. W. D. Uhler, Pennsylvania.

MR. CROSBY: I second the motion.

CHAIRMAN TILLSON: Are more than two of these from the same state?

MR. DEAN: No, sir.

CHAIRMAN TILLSON: The constitution requires that there shall not be more than two from one state. You have heard the motion. Is there any discussion?

It has been moved and seconded that these names as read by Mr. Dean be made the nominating committee to nominate officers for the ensuing year. Is there any discussion? If not, all those in favor of the motion will manifest it by saying aye; opposed, no. The motion is carried.

Is there any other business to come before the meeting?

MR. CROSBY: I move that we adjourn.

MR. DEAN: I second the motion.

CHAIRMAN TILLSON: It has been moved and seconded that we do now adjourn. All those in favor of the motion will manifest it by saying aye; opposed, no. The motion is carried, and the meeting will stand adjourned.

Annual Dinner of the A. R. B. A.

The annual dinner of the American Road Builders' Association was held at the Hotel La Salle, Chicago, Ill., on Wednesday evening, December 16, 1914, the third day of the eleventh annual convention. Over three hundred members and guests attended.

During the dinner a musical program was rendered by a male quartet, which also led the diners in the singing of popular songs. Comparatively few after-dinner speeches were made, most of the time being taken up by a vaudeville entertainment furnished by professional entertainers comprising several singers and dancers and a "magician."

Before the vaudeville brief speeches were made by President W. A. McLean, who acted as toastmaster; Hon. W. H. Armstrong, Minister of Public Works of the Province of Nova Scotia, Canada, and Wm. G. Edens, President of the Associated Roads Organizations of Chicago and Cook County. At the close of the vaudeville entertainment an address was made by State Highway Commissioner John N.

Carlisle, of New York, and Eben More, of Eben More & Co., Consulting Engineers, Airdrie, Scotland.

The menu follows:

COTUIT OYSTERS

PETITE MARMITE WITH PARMESAN

Celery — Olives — Radishes.

FILET OF BASS, LA SALLE

Potatoes Parisienne

SUPREME OF GUINEA-HEN WITH VIRGINIA HAM

Grilled Sweet Potatoes — Asparagus Tips

GRAPE FRUIT AND ORANGE SALAD

ICE CREAM FANTASIE

Assorted Cakes

CHEESE

Toasted Crackers

DEMI-TASSE

Cigars — Cigarettes

Thursday, December 17

FOURTH SESSION, 10:30 A. M.

CHAIRMAN PARKER: Gentlemen, in the absence of the President of the Association I have been requested to preside today. The discussion today is upon brick roads and streets, to begin with, and Mr. John Laylin, Division Engineer of the Ohio State Department, is going to read to you a paper which will later be discussed, Mr. Laylin. (Applause.)

Brick Roads and Streets

By JOHN LAYLIN

Division Engineer, Ohio State Highway Department

This paper will treat this subject largely from the writer's experience in municipal and state highway improvement work.

Ohio statutes provide for state aid in road building on a system of inter-county highways, so-called, lying wholly without the limits of municipalities, comprising a network of roads aggregating about 9,500 miles, and connecting all county seats and towns of any considerable size within the state.

The law is very flexible in regard to the distribution of costs of improvements, and was designed to meet all possible conditions, but in a general way it may be stated as 50 per cent. to the state, 25 per cent. to the county, 15 per cent. to the township and 10 per cent. to abutting property. County commissioners designate the particular section of the particular inter-county highway that shall be improved in any

year and guarantee the payment of costs to be levied against the county, township and property owners, and further determine the particular type of improvement to be made.

Inasmuch as the county commissioners are a party to every contract made and entered into, it may be readily understood that the Highway Commissioner does not select the particular type of pavement to be constructed, even if inclined so to do. Types of pavements are generally selected, however, that best suit traffic conditions and utilize suitable materials near at hand.

The Highway Commissioner has ever tried to treat all material and supply men with the utmost fairness, and his splendid success in the management of the department and the construction of a great highway system is largely due to the hearty cooperation of all classes of material and supply men.

After a type of pavement has been selected for a section of road to be improved, then the Commissioner does insist that the construction of the work shall be of the best for that particular kind of pavement.

The essentials of a good road or street are good alignment, easy grades and perfect drainage.

Resident engineers working under the directions of department division engineers make the field surveys, plat the alignment, profiles and cross sections, and work out all questions of new locations, grades, cross sections, sewers and drains, bridges and culverts, and plans are made to show type and dimensions of foundation, thickness of sand cushion, kind and dimensions of curbing, kind and thickness of expansion joints, all details of drainage, bridges and culverts, and everything not fully set forth in the general specifications of materials and workmanship.

In passing, it might be said that efforts are always made to secure a clear sight view of at least 300 ft., a maximum gradient of 8¾ per cent., and a drainage system that will maintain a water level well below the base of foundation of pavement.

The 1914 specifications for brick pavement improvements provide as follows:

That in the preparation of the subgrade, all muck, quicksand, soft clay and spongy materials that will not consolidate under the steam roller shall be removed; that backfilling of all excavations shall be rammed in courses of not more than 6 ins. of loosely filled earth; that embankments shall be built up from the bottom in successive, even layers not exceeding 12 ins. in thickness; that each of these layers shall be rolled until thoroughly compacted; that when the slope

upon which material for embankment is to be placed exceeds two to one, such slope shall be furrowed before any material is placed thereon, and that areas on which embankments less than 1 ft. in depth are to be placed, shall be broken up by plowing or other means.

After the surface of the subgrade has been properly shaped the roadbed shall be thoroughly rolled and compacted so that it does not wave or spring under the roller. Rolling shall be done with a self-propelled roller weighing not less than 6 tons.

That foundation for pavement may be made of either Portland cement concrete, old pavement, compacted broken sandstone, limestone, slag, gravel or vitrified clay.

Great care is to be used in selecting aggregates for concrete, all materials being submitted to tests to insure quality meeting requirements as specified in Bulletin No. 25, "General Specifications for Materials." Aggregates are so proportioned as to produce concrete, substantially composed of 1 part cement, 2½ parts fine and 5 parts coarse aggregates, in which the mortar shall be not less than 110 per cent. of the volume of the voids in the coarse aggregates.

Coarse aggregates may consist of crushed bowlders, crushed limestone, slag or gravel that will pass a screen having openings 1½ ins. in diameter and be retained upon a screen having openings ¼ in. in diameter.

A cubic yard of concrete in place shall not contain less than five sacks of cement.

Concrete shall be mixed in a batch mixer, so-called, the drum of which shall not make less than 15 revolutions, at a speed of between 15 and 20 revolutions per minute.

Materials shall be mixed sufficiently wet to produce a concrete that will require no tamping. Subgrade must be moist before concrete is placed thereon.

The surface of concrete shall be shaped by the use of a suitable templet cut to conform to the crown of pavement, and shall be floated in such a manner as to thoroughly compact the concrete and produce a surface the exact crown specified. The finished surface of the concrete shall conform so nearly to that indicated on the plans that it will nowhere vary more than ½ in. from the previously described templet or a 10-ft. straight-edge applied to the surface of the concrete and parallel with the center line of the pavement.

Care shall be taken to protect concrete from rapid drying out and freezing, and traffic is prohibited for 10 days from time of laying.

A thoroughly consolidated old macadam or gravel road, if of sufficient depth, may be considered satisfactory pavement foundation. The old road shall be thoroughly cleaned, and if irregular, shall be scarified, graded to the proper elevation and all depressions filled with the same material of which the course consists. All foundation material placed must be thoroughly filled, water-bound and compacted.

Rolled foundation shall consist of either gravel, broken sandstone, limestone, slag or vitrified clay. Sandstone fragments must not exceed 6 ins. in greatest dimension, and all other materials must pass a screen having 4-in. circular openings and be reasonably well graded from 4 ins. down to the smallest size found in the product.

Gravel shall not contain more than 15 per cent. of clay or loam.

Rolled foundation shall be constructed as a one-course water bound macadam pavement and brought to the proper crown and grade within the limits specified for concrete foundation.

That curbing shall be either sandstone or concrete of dimensions indicated on plans and quality as specified in said Bulletin No. 25.

That sand cushion shall not contain more than 8 per cent. by weight of clay or loam. Sand shall be spread over foundation, shaped with templet, rolled till compact, and made ready to receive the paving blocks.

That paving blocks shall be laid in an upright position upon the sand cushion in straight courses across the road, and shall be laid so that the longitudinal joints are broken approximately at the center of each block and the long dimension of the block is perpendicular to the center line of the road on the tangents and practically parallel with the radius of curves having a radius not greater than 150 ft.

All blocks to be laid with the lugs in the same direction and set as closely together as possible. In all cases the end joints shall be made close and tight, the joints to be at right angles to top and sides. The cutting and trimming of blocks shall be done by experienced men, and proper care shall be taken not to fracture or injure the part to be used.

After a sufficient number of blocks shall have been laid, the pavement shall be thoroughly dampened by sprinkling, and all soft, porous or unacceptable blocks will be marked by the inspector and shall be removed by the contractor. When any section shall have contained more than 10 per cent. of rejections, the blocks of the entire section shall be taken up and the cushion re-adjusted. As soon as possible after the

block in the pavement is inspected, rejections removed and replaced with acceptable block, the surface shall be swept clean and then rolled with a self-propelled roller weighing not less than 6 tons. When rolling and ramming are completed, the surface of pavement shall conform so closely to that indicated on the plans, that it will nowhere depart more than ⅜ in. from properly formed templet or a 10-ft. straight-edge applied to its surface.

Soon after the pavement has been compacted and surfaced, the joints between the blocks and the curb shall be filled with a grout filler composed of one part Portland cement and one part sand. Detailed specifications set forth manner of applying grout.

Paving brick specifications provide:

That the brick shall be standard wire-cut-lug or repressed paving block of standard size. The standard size of brick shall be 3½ ins. in width, 4 ins. in depth and 8½ ins. in length. The brick shall not vary from these dimensions more than ⅛ in. in width and depth and not more than ½ in. in length, and the brick of the same shipment shall not vary more than ⅛ in. in width or depth. They must be thoroughly vitrified and annealed, regular in size and shape and uniformly burned. When broken, they shall show a dense, stone-like body, free from lime, air-pockets, cracks and marked laminations. No surface of any brick shall have kiln marks more than 3-16 in. in depth or cracks more than ⅜ in. in depth, and the wearing surface of the brick shall not have kiln marks more than 1-16 in. in depth and shall be free from cracks. The brick shall have not less than four nor more than six lugs, all on one side of the brick, such that when the bricks are properly laid in place in the pavement, the joints between the brick will be not less than ⅛ nor more than ¼ in. in width. The name or trade mark of the manufacturer, if shown on such brick must be by a recessed design or by recessed letters and not by a raised design or raised letters.

If the edges of the brick are rounded, the radius shall not exceed ⅛ in. The brick must not be chipped in such a manner that neither wearing surface remains intact or that the lower or bearing surface is reduced in area by more than one-tenth, but such brick, if otherwise satisfactory, may be used in obtaining the necessary half brick for breaking courses and the necessary pieces of brick for closures; provided that the wearing surfaces of the part of brick used shall be intact. The brick shall not be glazed. To determine whether the material of the brick as a whole, possesses,

to a sufficient degree, strength, toughness and hardness, samples of the brick shall be submitted to the rattler test. The test shall be made in accordance with the method and in a rattler as described in the recommendations by the Submittee on Paving Brick to the American Society for Testing Materials. Five samples of each kiln or shipment may be selected; one sample from what appears to be the softest brick and one sample from what appears to be the hardest brick, neither of which shall lose of their weight more than 24 per cent.; and three samples representing an average of the kiln or shipment which shall lose of their weight not more than 22 per cent.

The quality of the brick shall be of such uniformity that the range between the highest and lowest loss by abrasion shall not exceed 8 per cent. If the kiln or shipment of brick should fail to meet the above requirements, and it is fair to assume that it would meet them, if not more than 10 per cent. are culled, then the contractor may, at his option regrade the brick. When the regrading is complete, the kiln or shipment shall be resampled and retested, as under the original conditions, and if it fails to meet any of the above requirements, it shall be finally and definitely rejected. Sampling may be done at the factory prior to shipment and brick accepted as the result of such sampling will not be rejected as a whole but will be subject to such culling as may be necessary to meet all of the requirements except that of the rattler test.

The Ohio State Highway Commissioner let contracts for brick roads in 1912, 1913 and 1914, mileage as is shown in the following table:

	1912	1913	1914
Mileage brick roads contracted	33.47	27.71	164.0
Per cent. brick road of total mileage of all roads	20.7	17.7	32.5
Contract price for brick roads	$507,899.19	$486,925.87	$3,415,584.45
Per cent. of total contract price of all hard surfaced roads	36.4	35.3	46.3
Average contract price per mile for brick roads	$15,680.00	$17,572.00	$20,827.00
Average contract price for brick roads per foot in width per mile	$1,150.00	$1,379.00	$1,364.00

The contract price for brick roads included grading, draining, curbing, and paving for the years 1912 and 1913, but also included bridges and culverts for the year 1914.

In the preparation of our plans it is our endeavor to embody the use and requirement of the best possible foundation, and the best possible drainage consistent with the economy of the road.

Following this rule, a concrete foundation for brick pavements is generally provided, and as the greatest assurance against longitudinal cracking in the wearing surface, the advantage of a dry sub-base is considered essential. It is the general belief that brick pavement cracks are caused more by frost action than high temperature stresses. In fact, a sufficient and proper drainage of the subgrade of all roads, including the brick road, is regarded as of the utmost importance. Frost has little effect where moisture is almost entirely absent; hence these provisions carefully observed are certain to reduce to a minimum all deleterious climatic effects. There are a few examples of brick pavement construction that the writer especially desires to call to attention.

The Cleveland-Buffalo I. C. H. No. 2, in Lake County, is a 2½-mile improvement with brick surface 18 ft. in width, curbed on either side, with a 24-in. concrete gutter having a 2½-in. concave surface. These gutters collect the water that falls on pavements and lawns and conduct to catch-basins connected with a system of underground drains. The pavement is laid on a 4½-in. concrete foundation. The lawns slope back from gutters and the park-like effect is very pleasing.

Many of the brick pavements in Northern Ohio on streets and roads having a sandy or gravelly soil, are laid on natural bed foundations, and where traffic is light or medium, such streets are giving first-class service. Many such streets have been been in use 20 years and more, and they give every evidence of being good construction.

Two streets in Norwalk, Ohio, have been laid on natural bed foundations and edged with vitrified curbs. These curbs were made on a regular paving brick machine with three out of four of the cutting wires removed, thus making a block that when burned was 4x8½x15½ ins. These blocks were set with the 8½-in. dimension vertical and set in gravel or crushed limestone.

The pavement when grouted with a 1:1 cement mortar practically became monolithic. This work has been in place less than two years, but it looks like good, cheap pavement construction. The writer has watched for a number of years two streets in a small village that were curbed with ordinary paving block stood on end and thoroughly grouted. The earth next to such blocks has worn away in places and the edges of bricks have become rounded, but they are still doing business and holding the pavement intact.

A number of Ohio roads have been designed and constructed with concrete foundation and curb constructed monolithic, and such construction is to be recommended.

Cuyahoga County, Ohio, is noted for its brick country roads, there being over 350 miles outside of the City of Cleveland. These roads have generally been constructed 14 ft. in width, located on the side of the roadway, the balance of roadway being graded to a width of 7 ft. or more and used as an earth drive.

The earlier roads built were constructed with rolled foundations and not very much attention was paid to matter of drainage, but brick roads as now constructed are well drained and provided with concrete foundations. Concrete and sandstone curbing is employed, and in all cases the pavement slopes so the surface drainage flows away from the earth track. Raised curb is often used on the outside, and on hills raised curbs are used on both sides of pavement, drainage being provided by catchbasins and underground drains. On hills, hillside block and Medina block are used. Traffic is very heavy in and about Cuyahoga County, and the brick roads seem to have solved the road problem.

In conclusion, it may be said that brick roads and streets should always have a solid subgrade, perfectly drained; that a concrete foundation should be provided wherever traffic conditions are heavy, and that the surface of concrete foundation should be made true and smooth and exactly parallel with the crown of the street; that the sand cushion should be thoroughly compact and from 1½ to 2 in. in thickness, that a cement grout filler is the best filler; and that a brick road is a dependable road.

The paramount interest in brick roads that more greatly concerns the tax paying public is the same that is involved in the expenditure for any road no matter what the type, and that is the efficient building of the road itself, the compliance with the plans and specifications. The proper construction of a brick road is no more difficult than the construction of any other kind of road, but every requirement of the plans and specifications should be carried out. Plans, specifications and contract pre-suppose that each and every requirement therein is a part and parcel of a necessary adjunct to the value of the road intended to be built. A complete cooperation of the combined influences of public sentiment, official authority and the obligation of the contractor is necessary to reach the ideal in road building. Without the combined forces of all, the most conscientious official, the most diligent contractor or an anxious public acting singly and alone cannot attain the best results.

CHAIRMAN PARKER: Gentlemen, you have heard a very interesting, carefully prepared and logically concluded

paper, and I imagine that you will have some difficulty in picking it to pieces. However, the next gentleman who is going to enlighten you is one who probably knows more about the question than anybody else of my acquaintance, and that is Mr. Wm. M. Acheson, of Buffalo, Division Engineer of the New York Highway Commission, Mr. Acheson. (Applause.)

WILLIAM M. ACHESON (Division Engineer, New York State Highway Commission): Mr. Chairman and Gentlemen: My discussion will probably take up more the construction details than the economic side of brick construction.

In the building of a brick pavement, I think that the construction details are very important and that every one of them should receive its full weight. The preparation of a roadbed or subgrade is one of the most important details in connection with the brick road pavement, or with any pavement, but I think it applies more truly to a brick pavement. By this is meant getting it into a condition to aid the pavement in giving the greatest durability, and, at the same time to afford the greatest resistance to all climatic conditions and changes. In this, drainage is a very essential item. All bad, soft or yielding soil should be excavated and taken care of by tile drainage or by dry soil placed in it over the subbase condition. After this detail is gone through with, the subgrade, after it has been properly compressed and compacted by rolling, should agree with the finished section of the pavement both as to alignment and grade. Now, in connection with the drainage proposition I believe that especially on cuts we should look out for trouble, for frequently when we go into cuts we open up sidehill seepage, and I believe that in that connection they should be porous, that we should look to the sidehill drainage and place porous tile on the upper side of the road, and this tile at all times should be at least 8 to 10 ins. below the frost line, for it is necessary to place the tile under the roadbed. This tile should be so placed that it has a quick run-off. These ditches should be so arranged that we are insured of a quick discharge of water at all times from the immediate vicinity of the road. After drainage the next important item in connection with the subgrade is the handling of cuts and fills. Fills should always be made with a maximum layer of 6 ins. and should be rolled with a grooved roller. In all cuts particular attention should be paid to the soil, for it has been frequently demonstrated from past experience that on cuts there are many soft, spongy spots. This is primarily caused by the seepage system which cuts open

up. After the subgrade is properly prepared as to its rolling and drainage, an important consideration is the alignment of the subgrade in connection with the finished pavement. The alignment of the subgrade and the alignment of the finished pavement should at all times coincide. You should be sure that you get your finished pavement absolutely down on the subgrade. No deviation of any kind should be made from that condition. If you discover such deviation in the building of the subgrade you won't have the proper alignment and the subgrade should be rebuilt. If you will do that in constructing your pavement it will be a step forward. After these details, we take into consideration the concrete base. In New York State we regard today the concrete base as one of the most essential details for the real life of the pavement. Now, I say this after the experience that we have had for the past year on all the roads, and we have quite a number of brick roads in Erie County and Niagara County where we have had defects. Men have gone out and they have made an investigation as to the cause of these defects. Sometimes they found they were due to an upheaval, to cracks, to breaking of the bond, and in 90 per cent. of the cases this was all charged to the foundation. Frequently we found that after a frost came the foundation popped up, and it broke the pavement. We went into it and we found that the sub-soil was full of moisture and that the drainage system was such that it didn't take care of it. We found that in some cases where the roads were built under the former specifications in New York State the use of local material was allowed. This local material was sometimes on a 1:6 mixed local gravel and it specified that about 40 per cent. of it should pass through a ¼-in. screen. Well, when we went in and analyzed that concrete there was no stability to it. It didn't offer any resistance. It just simply popped up and one man could go in with a pick and shovel and probably dig out 10 yards in a day. That condition shouldn't ever exist. A man shouldn't be able, on the proper kind of a pavement, to dig out more than 6 sq. ft. in a day.

Another thing that we have done in New York State during the past year is to insist that the concrete foundation upon its completion should be smooth and its grade and crown parallel to the finished section of the pavement. Now, we try to bring that up from the subgrade to the concrete pavement, to the sand cushion and to the finished pavement —all those surfaces parallel. That might seem like going a little bit too much into detail, but where we found the bond

was broken on the different pavements, we have gone into that and found out that probably in one section of a pavement where we have taken up 4 or 5 sq. yds. they had a sand cushion of ½ in. in one place and probably a sand cushion of 2 ins. in another, and the trouble was primarily caused by the concrete foundation not being parallel with the finished section of the pavement.

Here is another detail that I think should be brought out at this time in connection with concrete pavement. In New York State our specifications call for a concrete base and so much per cu. yd. of edging, and the bids are taken upon lineal feet. Now, I think in this connection that the concrete specified, and the bid price per cu. yd., should include the pavement and the edging. The contractors can figure on that just as well as they can figure so much for edging and so much per cu. yd. for base work. And by doing that we are going to get the same type of concrete for our base as we get for the edge. Every one knows that we have got to have a better concrete, or have got to have a very firm concrete for the edging. If we don't the edging will wear off very soon. We have pavement built on the boulevard,—probably some of you gentlemen have seen it—on which the edging is now down a half an inch, or from a quarter to a half an inch. This was gravel concrete. Had this been the proper kind of concrete that condition would not have existed.

The New York State specifications call for a 1½-in. sand cushion. I believe that this is the ideal sand cushion. The sand passes through a ¼-in. screen. Now, the sand that is used for sand cushions should pass through a ¼-in. screen because we have had conditions where we have taken the pavement up, and found out that there was one pebble in there, probably ½ in. or even to 1½ ins. in size, and one brick was riding on that pebble. That caused that one brick to break the bond.

In this connection I want to state that on some of the roads in New York State we took a census of the traffic from seven o'clock in the evening to seven o'clock in the morning to find out how many farm vehicles went over the road. We were only looking out for motor-driven vehicles. From seven o'clock Friday night until seven o'clock Saturday morning 372 vehicles passed over that one road. Fully 50 per cent. of the more than 300 motor-driven vehicles had double tires on the rear. Now, there is the condition. That is one phase of the traffic that you have got to look out

for in building your brick road in connection with the sand cushion. Now, if these heavy motor trucks, loaded just as heavily as they can go with fruit and vegetables, pass over a brick that is riding on a pebble, that brick has got to go somewhere. It is acting as a fulcrum. If that one brick goes, then a whole area goes. Further, in taking up some of these conditions I have discussed them with Mr. Blair and others. All defects or failures which appear in completed work between the different roads are taken up and discussed with the men of our engineering force in order to prevent a recurrence of the same. We have in each county in New York State during the construction an engineer who is in charge of the construction work in that county. There is also a maintenance man who has charge of the repair work. When any problem of maintenance comes up the condition is reported to the office and is discussed at the meetings which are held every Monday morning during construction seasons. The idea of that is to make both the construction and the maintenance men familiar with the conditions, the maintenance man familiar to repair and the construction man familiar with the defect. If the concrete base is absolutely smooth—and it can be gotten that way, for we are getting that condition—you will obtain a sand cushion that probably won't deviate more than ¾ in. from a thickness of 1½ ins. over total length of the road. But you have got to watch the concrete to get the proper consistency. It can't be too wet. The sand cushion is rolled until it is compact and firm. We allow probably as a maximum 20 per cent. of loam in our sand. We do that because we have got to do it. I would like to see 10 per cent. rather than 20 per cent. Of course, that is one matter that perhaps will always be a subject of a great deal of discussion.

After this sand cushion is prepared and rolled then the brick are laid on it. In laying the brick, the brick should be carried to the paver so that every brick is in such a position for laying that the paver will get the lugs in the same direction and the best face uppermost. To do this we have got to have an intelligent foreman who knows the brick business from A to Z to instruct these laborers how to do it, because the gangs are changing from day to day. A brick should always be laid on its head, and at no time should there be any deviation from this form of laying. In connection with that, I was at Atlanta and while there I heard them discussing the laying of brick on the side. It seems to me from my experience with the brick pavement

that the only way to lay it is on the brick's edge. Probably I can't give any tangible reason except practice.

In all of our brick propositions we have been attempting to break in engineers who were absolutely competent as superintendents and our aim is at all times to have a capable, experienced man who is an engineer as the inspector on the job. We do that and have him work in conection with the contractor. If the contractors are a little bit lax in laying their bricks and carrying them out he gives the benefit of his experience to the contractor or the foreman in charge of the brick gang, so that they can carry on their work. It means a benefit to the contractor. It means efficiency for the state, for it cuts down the time for inspection which is necessary, and it means satisfaction to the public to get their jobs completed. If bricks have to be replaced—picked up with the tongs—there is a tendency to disturb the sand cushion, and if we can have the men so instructed by the engineers and contractors that they will carry the brick so that there are very few changes in placement, that aids in the finished pavement. After the bricks are properly placed we use about a 6-ton mechanical roller, and we insist that the contractor roll every day whatever brick he has got down. We go further than that. We insist that they grout. We don't allow them to get down a large area and wait for grouting. While some contend that brick may stand for several days uninjured before the filler is applied, one rain storm will do much damage to the pavement—and to the contractor, from a money standpoint. It hurts the contractors and it hurts the division engineer to go out there and convince him he has got to take up the pavement. On the Lake Shore Road they had 2,000 ft. of brick down and they had a rain storm. The sand that we used was shell sand. There was very little loam in it, probably 5 or 6 per cent., and then it held the moisture. There was practically no grade, but in all of our edging work we put down a ⅞-in. pipe through the edging at the base of the concrete to provide for drainage and to protect the contractor from any rain storm which may come. This contractor had 2,000 ft. of brick laid and he wanted to grout it and the engineer didn't believe it was in condition to grout and told him to roll it. He rolled it. He had to take up the 2,000 ft., both the sand cushion and the brick. Had the contractor grouted as much brick as he got down every day, he would not have had that trouble.

In conclusion I want to offer a suggestion. This applies

probably more to brick pavements than any other type of pavement that is constructed of either brick or sandstone. It applies more to state road work than it does to city work. Contractors get their brick during the winter and frequently when they begin excavating they are careless in casting the dirt and sometimes they cast the earth over the brick or probably the brick are along a road where it is very dusty and the automobiles cover the brick with dust. Then it rains and that naturally clothes the brick with dirt. These bricks cannot be grouted successfully. We have had jobs that went on during the past year where we have had to wash four miles of brick with a hose because the contractor in constructing the subgrade threw the soil over the bricks and when he got ready to lay the bricks there was a film ot dust and dirt all over them. If those bricks had been laid that way there isn't any doubt in my mind that the grout would have failed. There could not have been any bond there and they would have blamed the brick pavement when probably it was really due, primarily, to the engineer, for he should have seen the condition on this job, and made sure that dirty brick were not placed in the pavement. I thank you, gentlemen, very much. (Applause.)

CHAIRMAN PARKER: This discussion by Mr. Acheson shows you that he has gone into the subject very carefully. He is a very good example of the care that is taken in the State of New York now to do all their work. The next gentleman that is scheduled to take part in this discussion is Mr. Leonard S. Smith, Professor of Highway Engineering at the University of Wisconsin.

LEONARD S. SMITH (Professor of Highway Engineering, University of Wisconsin): Mr. President and Gentlemen: I have been very much interested in highway work for fifteen years. What I have to say is based not upon practical experience but upon very careful examinations and study of highways in many different states, both in this country and abroad. The details of construction have been so fully discussed that it seems futile for me to attempt to add very largely to this discussion along these lines. I am sure we have all profited by this paper, coming as it does from a man who has constructed pavements so successfully. I cannot resist the desire to give Cleveland and Cuyahoga County a well earned compliment. In all my travels and inspections of many months abroad I never saw such a fine system of highways around Paris or London or Munich or any other large European city as I have seen leading out of the City of Cleveland. (Applause.) We need, we Ameri-

cans, to consider this fact. We hear a great deal about pavements in European cities, but we can show them something also. There are very many American cities which could, if they chose to do so, duplicate that wonderful system of brick highways in Cuyahoga County, a system usable every day of the year and every hour of the day. I feel like congratulating the people who live in the Mississippi Valley, because you are so close to paving brick factories that you are able to use such materials and use them at a reasonable price. I regret very much that in my own state of Wisconsin we do not have a single paving brick factory. Instead we have our enormous deposits of excellent gravel. Because of high freight rates the use of brick in my state will have to be limited to a less amount than what we would otherwise use.

Now, I wish to make a few general statements that I hope may be of some interest to you. First, in regard to the selection of a pavement. The system commonly found in America is responsible for a very large part of our pavement failures. The selection of pavements in this country is absolutely wrong, as I see it. The reason why Europe has so much finer pavements than we is not because European highway engineers know more than we do, it is not because they take greater pains in their specifications, but, gentlemen, it is in large part because the selection of pavements in Europe is put in the hands of experts, where such selection belongs, instead of being left to politicians and property owners, as often is true in America. Europeans have learned that the expert saves them money. Their experts are not the rulers of the people, as some seem to believe, but are indeed the servants of the people. The German people have a much greater appreciation of science than we. The theory in this country—that we are all born equal and that we grow up equal in knowledge—is absurd. In fact, no one believes in the Jack-of-all-trades. The belief that the man who lives along the street can choose its pavements more wisely than the trained expert, has no real basis in fact. The foundation of such expertness is generally limited to consideration for his own pocketbook. And how can any such consideration as that of first cost only, wisely determine the character of a pavement? Such a system does not obtain in Europe, but the trained expert selects the pavements.

Something was said yesterday in regard to the engineers not putting in any better pavement than public sentiment would justify, or something like that. I do not find myself, as I understand the significance of that statement, quite

in accord with it. Will we not make progress faster and more certainly if those in charge of public improvements entertain ideals a little ahead of the people? This is in fact the general practice even now. If everything we were to do must first be subject to a vote of approval by the common people we would be greatly handicapped. It seems to me our engineers had better put down a road that for the first year at least is a little better than the people along that road think they ought to have. Perhaps it may be considerable better, for at the end of one year these people will be converted to a more truthful point of view, and in the end be grateful that their views were not followed.

The next point that I wish to emphasize is the gospel of maintenance. I am very glad to say that in this country I have noticed in the last five years a rapidly growing sentiment along the lines of increased efficiency of road maintenance. This matter has less significance with reference to brick pavements perhaps than to any other types, because our brick pavements don't fail so generally or so quickly as other cheaper types of pavement. But even here I find myself feeling that if after the first winter our engineers will go over the brick roads, as no doubt they frequently, but not always do, and pick out the soft bricks, note the cracks and settlements and repair same promptly, a stitch in time would save ninety-nine even with a brick pavement. Certainly the gospel of maintenance is true with other types of pavement. Moreover the same authority which directs the construction of roads and pavements should direct their maintenance. Foreign engineers realize fully the importance of this principle, and the result is reflected in their generally fine roads. In Europe they start in to repair the roads the day after they are built. Indeed, the same contractor who builds a broken stone road piles up along the road, every 100 meters or less, a pile of different sizes of stone, needed for the repair of that road. And the day after the road is completed and each following day a man goes along and puts a spoonful here and a shovelful there and if needed a wheelbarrowful there. The result is a good road all the time. They start in to repair roads the day after they are built, while in America too often we start in to repair our roads the day after they are ruined. We need to emphasize that point. In no other way can we make money go so far as by adopting a system of systematic maintenance.

Gentlemen, we in America know just as well how to make pavements as they do in Europe. Indeed, the European engineer looks to America for the solution of many pave-

ment problems, especially problems connected with bituminous pavements. A few weeks ago in connection with some consulting work I was doing in a city of over 400,000 people, I had occasion to inspect several miles of brick pavement that went out of guarantee in 1914. I regret to say that in the whole area I was not able to find more than a block or two that would be what I would call a good brick pavement. The pavement had failed for two reasons: First, because of poor brick, second, the cement grout had failed miserably. There seemed hardly a brick that was properly protected on its edge. I want to say to you brick men, if there are any present, that that is the way to destroy your business. It is up to you to see that that sort of thing is not generally done. In this city that I speak of brick pavements are not in great favor, and can you wonder? I am going to make this fact the occasion of a timely warning. I believe, gentlemen, that we will get along much faster, you will make more money—that appeals to you Americans—you will make more money out of your brick, if you pay more attention to your inspection, and that inspection had best start right in the brick factory. It had better start, it seems to me, from the choice of materials, the raw materials, the shale itself. Especially do you need, it seems to me, to be more particular in the selection of the brick as it goes into the cars for shipment. In a number of cases I fear the men who are doing this work are inadequate in experience, inadequate in education, and, perhaps, inadequate in numbers. I believe that it is greatly to your advantage, and certainly greatly to the advantage of our people, if you inspect your brick at the factory more closely than you are sometimes doing now. I may be entirely mistaken about this, but as it seems to me, it would be just as ridiculous in our state, where we have produced enormous quantities of white pine lumber, if we sawed our logs all into one grade instead of as we do, into number 1 lumber, number 2 lumber, number 3 and number 4. Just as absurd would it be for us to put all our lumber into one pile, selling it at a single price, as it is for you brick men to put all of your brick, or nearly all of it, into one pile, and call it paving brick. Now, I am all on the outside and I may be entirely wrong on that proposition, but that is the light that comes to me. We will make progress faster, it seems to me, if you gentlemen, instead of paying the unnecessary expense—the frieght to the distant city, the cartage on the brick rejected out on the street, its carting back to the railroad track and then again back to the distant factory, expenses which make this

brick practically a total loss—it seems to me it will be far better for you, you will make more money yourself, if you will only be more careful in your selection of the brick.

Some engineers are altogether too particular in regard to their inspections. I have frequently found excellent brick in the pile that had been rejected. I have not time to stop on that, but it seems to me we engineers need to consider a little more carefully, to be more expert in the selection of the brick to be rejected, than we have been in the past.

I am glad to bear witness to the fact that the attitude between material men and the general public has changed greatly in the last ten years. I can remember ten years ago when the material men were very unwilling to give away their experiences. Such knowledge was regarded a state secret, private, and not to be disclosed or given away. It constituted their stock in trade. This showed an entire lack of team play. How differently are such matters regarded today is illustrated by this very congress. In the football field we find it is absolutely necessary in order to put the ball over to have team play. I believe in business it is equally true that we go forward together. One crowd of men can't make progress with the great mass left behind them. We have got to go forward together, material men, manufacturers, engineers, contractors. We need team play; we need team play in the families; there is the first place to teach team play. There should be team play between the father and son, between the mother and daughter. Perhaps if we were taught team play earlier in the game we would not be so lacking in it as we grow older.

I am glad to see the evidence of a growing spirit of team play between the material men and the public. You are getting to urge your materials promiscuously less and less. You are now aware of the fact that the best pavement under all circumstances is not your special pavement, and to some extent you study the needs of the community and think about the future of your product five years from now and ten years from now. It is only as you do that that you are going to make the most of your business. If your concern thinks only of the sales, of your progress in 1914, and thinks not of 1915 and 1925 you are not going to make as much money as you otherwise would, and our communities will not get the service that they properly are entitled to. I know of no other one association that has done any more, perhaps as much, to bring about this condition of team play as has the National Paving Brick Manufacturers' Association. I have seen evidences, and you have seen evidences, of their desire

to get a first-class specification. I believe they have done this community and every community in the United States a very great service. It may be they had selfish motives, but the fact is they certainly have conferred blessings on us all. And other material men have done likewise, the concrete folks have preached this same sermon to the people and other material men have done the same and it is a most hopeful thing that this is generally true today. We owe a great debt of gratitude to the men who are conducting your campaign for standard brick pavements. I wonder if you manufacturers appreciate the good that is coming to you because of such efforts? Are you supporting your officers?

One of the greatest improvements in paving brick is the new style of brick—the wire-cut-lug, now so generally made in this country. It should greatly add to the life of a properly built brick pavement. Ten years ago I had a sample of a brick road that Mr. Blair sent me from Terre Haute, a pavement which had about 15 years of service and it impressed me greatly. I said, "Why don't you make that kind of brick today?" He did not give me a very satisfactory answer, but in the meantime we have seen the development of the wire-cut-lug brick. It seems to me this brick gives great promise for very materially improving the brick road.

There is one other point that I wish to make and then I am through. I was very much impressed in studying abroad the matter of pavements and finding the excellent results generally secured. Some of you may not know that their specifications do not compare with these specifications that have been discussed in this congress. They do not go into anything like the detail of road construction that our specifications do. Their specifications, if you read them,—I care not what kind they may be—will impress you as being incomplete, as affording a great many loopholes for escape. But, in spite of that, they produce fine pavements. What is the reason? Let us study this case, the reason why with incomplete, inadequate specifications they are able to construct uniformly good roads and good pavements under traffic conditions much more strenuous than those we have here. The explanation is this, and I say it to the contractors: It is due to a certain loyalty which the contractors have towards that work. It is due to their loyalty. They seem to have only one way to do a thing and that the best. The short cuts, to save money and spoil the pavement seem unknown. Certainly this is true of Germany and France; I will allow that it may not be so true of England, and you would not be surprised since we are English ourselves, most

of us. (Laughter.) Now, the reason as I see it is this: This contractor's father was a contractor, his oldest son is going to be a contractor, and some way or other they have got it in their heads that their business is to make a first-class pavement. The present contractor was taught by his father; his son is now in the same business. He looks forward to taking his father's position. Anyway, he does the work just as well as he knows how, and the engineer does not have to stand over there and lash him to get this result. It is this spirit of loyalty, gentlemen, that I wish to commend. I do not think that any kind of contract or any kind of specification that you can get up will take the place of downright loyalty to the work.

Just one other statement about that and I am through. It has been my experience—I am over 50 years of age—that the man that gives the most gets the most. Now, go back in your memory and see if that is not so, that one who is always on the lookout to skin the other fellow, who is striving to turn the short corner, the merchant who deals dishonestly, the doctor who answers calls only when sure of his fee, generally loses out in the long run, while the man who tries to give the most service for the money is finally rewarded; he can't prevent success, he needs not to strive for it. Such a contractor is never without work or without friends and best of all he loves his work—even in America money cannot take the place of that. I thank you. (Applause.)

CHAIRMAN PARKER: I judge, gentlemen, from your applause, that you agree with the last speaker. My experience is that having given a good deal I have received very little. (Applause.)

The next speaker, gentlemen, is the old war-horse, Major Crosby, of Baltimore. He is supposed to be one of the oldest in the field who have had experience in all lines, and is a person of great personal eloquence, so I trust all of you won't go out until you have heard him. Major Crosby. (Applause.)

MAJ. W. W. CROSBY (Consulting Engineer, Baltimore, Md.): Gentlemen, Mr. Parker has a habit of setting a pretty hard stunt for other people to follow and he has not departed from his usual custom, I find, in introducing me.

I want to congratulate this assembly most heartily and sincerely on the discussion to which we have just listened. In attending road conventions, ever since the early days of this association I think I have seldom heard a discussion that contained as much meat and was as forcibly expressed

as the one I have just listened to, as regards a great many general points.

The previous speakers on the subject of brick have fairly covered the subject. The paper of the gentleman from Ohio was most interesting and informing to me, as regards conditions in Ohio. The discussion by the gentleman from New York was extremely interesting as regards New York conditions and in my judgment he went thoroughly and well into construction details. Therefore, I don't propose to attempt to cover the entire subject, or even the subject of construction details fully. I merely wish to make one or two points. In making those points and in order to prevent a misinterpretation of any remarks that I may make I should like to state first that I am and have been for a number of years a great friend and advocate of brick pavement under certain conditions.

Now, referring again—and I probably shall have to do it pretty often—to Mr. Smith's remarks, because they were so comprehensive and well put, I must say that I am not an advocate of brick roads under any and all conditions; I do not believe in a permanent road any more than he does, or in a standard road for universal application any more than he appears to. I think the question of selection is most important. I might say further that I believe that brick pavements are rapidly increasing in application and use. The unquestionable tremendous increases in traffic in the past few years, accompanying the improvement of the public highways of the country has demanded a more substantial, more "dependable,"—a very happy word—road crust than we have formerly been accustomed to. Purely for illustration as to the increase in traffic, references to the reports of the Illinois Commission show a total increase in traffic there in five years of 21 per cent. That is an average increase of a little over 4 per cent. a year. That was between the years 1907 and 1912. Now, mind you, between those years in Illinois the road improvement in actual results had not gone on very rapidly, not as rapidly as in some other states. They were getting ready for it but had not built very many miles of road. In Maryland we began somewhat earlier and got a little start over Illinois. I commenced to take traffic censuses in 1904, that is just 10 years ago, and my figures show that there, where an average of the traffic on one road was 47 vehicles an hour in 1904, and this on a not heavily traveled road, in 1913 it was 94 per hour, or an increase of 100 per cent. in the nine years, a little over 11 per cent. a year. On another road, and this a more heavily traveled

road, the first traffic census showed in 1906 an average of 22 vehicles per hour, and in 1914, eight years later, it showed an average of 295 vehicles per hour, an increase of 1,240 per cent. in the eight years, or over 155 per cent. a year. On another road in Maryland, the average in 1910 was 21 vehicles per hour, 95 in 1912, and 252 in 1913. Censuses of Massachusetts, where the road improvement has gone on even longer, show corresponding figures, that is, that the traffic is rapidly increasing.

It is a fairly well known fact, but it ought to be emphasized a bit, that the minute you improve a road you invite traffic to it. The traffic does not consider declining the invitation, but even before the invitation is extended, before the road is completed, crowds in and tries to use it, and you must provide, in building a road crust, for the accommodation of a considerably greater traffic than existed over that road before the improvement was begun or contemplated. Those points I think perhaps illustrate why I say that the propriety of brick roads, notwithstanding that their cost is greater than that of macadam or some other crusts, is extending rapidly and that I think that there is a great field for them.

Now, I agree again with Prof. Smith most heartily when he says that he thinks it is up to the brick manufacturers to look far enough ahead to provide for ultimate success and not purely temporary profit. That is, that they must anticipate in their methods of production, in their methods of selection or grading, as far as possible the defects which are bound to occur in any product of human hands. They cannot produce something which is perfect and will remain perfect indefinitely. They must expect defects and try to forestall them, and their final success and ultimate profit will be the greater the more they pay attention to the future.

Some of the defects that are perhaps more common in brick pavements are the wearing of the brick pavements into holes. The gentleman from New York explained how, starting from one defective brick, the gradual disintegration of the area around that brick followed. The holes are a serious defect. If the brick pavement wore down uniformly and no holes appeared you can readily see that it would give far greater satisfaction with less cost for maintenance than a road which wore into holes needing to be repaired in order to keep the surface smooth. Another criticism of brick pavements in some cases is as to their noisiness. Until we have a standard for the measurement of noise it is difficult to say which is a noisy pavement and which is not a noisy

pavement, excepting perhaps in cases of those pavements that lie near the extremes in each case. As you approach the line dividing the noisy from the not noisy it is difficult to say on which side of the line any particular pavement lies because of the lack of standard for measuring the amount of noise. We had a rather peculiar case the other day in the City of Baltimore. Our Paving Commission, capably headed by Mr. Compton, who is attending the convention, was petitioned by some retail dealers and bankers on a certain street to substitute for a granite block pavement in fair condition a less noisy pavement. There was a single car track in the middle of the street. The Commission granted the request and ordered sheet asphalt placed on that street. The line of car tracks seemed to necessitate a brick pavement within the rails. It did not extent outside the rails. There was one liner outside, which I think was of wood block, and then the asphalt. The pavement was laid and after the street was opened to traffic, much to my surprise and no doubt to the surprise of the Commission, there were some vigorous complaints as to the increased—mind you, increased—noisiness of that asphalt street. The street cars seemed, in the minds of the people, to produce a great deal more noise than even the combined traffic over the entire street before. I was curious enough to go down and make some personal observations. My conclusions are, I trust, not extremely premature and are offered, I assure you, for what they may be worth, that there is at times a more penetrating noise than there was before. It seemed to come from the space between the car tracks where the bricks were laid. I theorized that the smoother surface of the brick pavement reflected the sound waves exactly in the same way that light waves are reflected from a smooth surface and not from a rough surface. The sound came down and was thrown back with less loss of sound from the smoother cement-filled brick surface than was the case with the stone block pavement, which was rough. Another thing, that might have caused the greater noise, is that a brick pavement is more resonant than a stone block pavement. The brick itself is what may be called more resonant than the stone block. Now, going on that theory and with the purpose of trying to find some way to improve the brick pavement it has occured to me that something might be done, without loss of value in the results, in the way of providing a cushion under the brick which would be of less help to the brick in reflecting sound waves, and of less help to the brick in living up to its resonant character than is

the ordinary sand cushion. My investigations as to the sand cushion did not begin with this matter of noisiness. The question of the depth of sand cushion and the questions of getting it properly in place have been serious ones for some time and have produced considerable discussion. It will be readily granted, I think, that the thicker the cushion the greater difficulty of getting it evenly spread and compacted and generally even in character. And it will be as readily granted that evenness in the sand cushion as to character, composition, compactness and its surface are all very important points for successful results. With the ordinarily-secured concrete base it is necessary to provide a certain depth of sand cushion to offset the inequalities which have been, up to the present time, apparently unavoidable in the surface of the concrete base. That gives a minimum cushion which can be used, but if only that minimum is used there isn't sufficient resiliency in the cushion under the brick to give the best results, and in the cases where the cushion is simply of that depth required to remove the inequalities in the concrete base, the pavement has not given as good results as where a certain additional amount of sand was provided as a real cushion to the brick, to give some elasticity, it might be called, to the pavement itself. Among the brick people I think that it is very generally agreed that about an inch is the least amount that can be successfully used for the cushioning effect. If half an inch is necessary for taking up the inequalities we have then the minimum cushion recommended of an inch and a half. The original recommendation of the brick people was for two inches, but I believe that extra half inch was then recommended because the perfection of the concrete base as to evenness had not reached the degree being reached now, and there is a tendency now to reduce the cushion to an inch and a half.

Even with the inch and a half cushion referred to, it is quite a difficult matter to get it evenly spread and as evenly compacted as is always desirable.

The thicker the sand cushion the greater its liability to displacement afterwards. Some very interesting papers have proceeded from this very locality on the question of displacement of sand cushion after the pavement had been in service. Along the lines of a car track for instance, where a brick pavement has been laid, the first defects generally appear close to the rail. They seem to be caused by the pumping up and down of the rail which dislodges the sand cushion under the brick and allows them to drop slightly

and result in an inequality, which itself results in the final destruction of the pavement. In some instances these pavements have been opened up and it was found that the sand cushions had been displaced.

I think it will be generally agreed that the question of displacement of sand cushions is pretty serious in brick pavement construction and an effort should be made to get the sand in place properly at the start and to provide for its staying in its proper place as long as possible. It occurred to me that possibly an advantage in the sand cushion could be had by putting in with the sand some of the bituminous material which we are now offered in such great variety in the market for other purposes. The bituminous materials are of rather recent development and I don't know that this matter of impregnating the sand cushion of a brick pavement has been actually tried anywhere. It it has I should be greatly interested to hear more about it. I suggested the idea to Mr. W. P. Blair, Secretary of the Brick Manufacturers' Association some time ago. It seems to me that by placing in some way a good bituminous material in with the sand for the cushion several results might be secured and a considerable advantage might be had in the ultimate results. For instance, it might be possible to still further reduce the thickness of the sand cushion and I have attempted to show you why as great a reduction as possible is desirable. This further reduction of the thickness of the sand cushion might be secured by the addition of the bituminous material without loss of resiliency. In other words, perhaps a mixture of sand and pitch a half an inch thick would give as much of a cushion effect as a bed of sand alone an inch thick. It might further help in reducing the resonance of the brick pavement and decreasing the noise. It might even further permit the use of certain materials which have not yet been successfully used as a cushion for brick pavements and this might be of advantage in certain localities. For instance, if saw dust were extremely plentiful and cheap, as it is in some localities, would not it be possible to secure good results and perhaps even better results than we have been securing with brick pavements, by mixtures of saw-dust and bituminous material in place of the ordinary sand cushion? The suggestions may apepar to be novel, but I accept the responsibility for offering them and I hope that they will receive some consideration.

There may be one objection to the use of the bituminous material in this way and that would be the additional cost, but if the reduction in the quantity of the sand or the

introduction of a cheaper material than sand is considerable, the extra cost of the bituminous material might be off-set, and finally, I think it will be rather readily granted that if proper bituminous material were used the tendency to displacement of the sand cushion under traffic and under service would probably be much less than the tendency of ordinary plain sand such as is usually used in the matter. If the results suggested are actually secured by the introduction of the bituminous material, will not the cost of maintenance be reduced and the brick pavement be made more satisfactory even than now? (Applause.)

CHAIRMAN PARKER: The next gentleman to discuss this question is Mr. E. H. Christ, of Grand Rapids.

Mr. Christ is not here. Will you take his place, Mr. Blair?

WILL P. BLAIR (Secretary, National Paving Brick Manufacturers' Association): The suggestions that are offered, differing from well known practice, which have given indisputable evidence of worth in brick road building, are not unwelcome; but as to all innovations and untried measures for improvement, they should only have their place in the experimental field, no matter how worthy they may seem, until their value is ascertained. Such a suggestion, for instance, is that offered by our friend, Major Crosby from Maryland, for the use of a bituminous cushion. That, as well as many other ideas in brick road construction, is being fully tried with the hope that a greater perfection can be attained. But in the meantime it is urgently advised that the details which have given the country so many magnificent streets be followed fully and completely complied with in the interest of the taxpayers of the country as well as that of our own—that these details so ably set forth by Messrs. Laylin and Acheson be continued in use, for it is these methods in construction that have resulted in pavements 20 and 25 years in age and use bearing enormous traffic without any repair in all that period.

Something has been said as to the manufacturers' share in trying to give to the public a perfect pavement. I want to give to you an assurance, as coming from a manufacturer, that we have been trying and we believe that we have largely succeeded—at least a great number of the manufacturers of this country—in placing upon the market a really high grade material and we are willing, and as evidence that we are willing to conform to our obligations in that direction, in the specifications that we offer to the public, you will find a permission coming from us at the last moment that objec-

tionable brick may be rejected. I believe that is all I care to say. Thank you.

CHAIRMAN PARKER: Mr. Blair was unusually brief. (Laughter.) I knew, gentlemen, that he had a lot of things that he had got to get off some time during this convention, and I am giving it to you in installments. The next speaker is Mr. E. A. James, the engineer of the County of York, Ontario, on the subject of brick pavement. Mr. James.

If Mr. James is not here you are permitted to discuss the question which has been so ably presented to you this morning and I will be glad to recognize any gentleman that has anything to say that has not been said already. I don't think it is necessary to repeat anything that has been said and any new information or any information that you may yourselves desire is germane to the subject and we should be glad to have any of you take part.

NELSON P. LEWIS: I would like to ask the members of the Committee on Resolutions to gather here for a brief meeting immediately after this morning's session. They are, besides myself, Mr. Sargent, Maj. Crosby, Mr. Dean, Mr. Hirst, Dr. Pratt, Mr. MacDonald of Iowa, Mr. MacDonald of Connecticut, and Mr. Foster.

E. L. POWERS: Mr. Chairman, I have a communication I would like to read. It is from Mr. E. H. Lee, of Chicago, President of the Western Society of Engineers:

Mr. E. L. POWERS, Secretary,
American Road Builders' Association,
In Convention, International Amphitheatre,
Chicago, Ill.

Dear Sir: On behalf of the Western Society of Engineers, I wish to extend to your convention the privilege of our society rooms at 1735 Monadnock Block, corner of Dearborn and Van Buren Streets. We trust that members of your convention will feel free to make use of our rooms as downtown headquarters.

With best wishes for your continued success in this work. I am,

Yours respectfully,
(Signed) E. H. LEE,
President.
By J. H. WARDER,
Secretary.

CHAIRMAN PARKER: I hope, gentlemen, you will feel perfectly free to discuss these questions. Mr. Connelly.

MR. CONNELLY (Racine, Wisconsin): I would like to ask Mr. Laylin the main objection to using the brick with the raised letters?

MR. LAYLIN: Mr. President, we all recognize the importance of thorough grouting in our brick pavements. It has been found by experience that grout does not fully fill the joints with raised letters. I think that answers the question.

MR. CONNELLY: Don't they answer the same purpose as the lug?

MR. LAYLIN: No, too many types of brick have too many letters. If they had only about four letters, they would answer the purpose.

M. F. BRAMLEY (Pres., Cleveland Trinidad Paving Co., Cleveland, O.): Mr. Chairman and Gentlemen: I had the distinguished honor of actually working on the first brick pavement, I guess, that was laid in Cleveland. If Mr. Laylin had asked my permission I would have asked him to modify his specification to one extent only. That was emphasized by the learned professor, Mr. Smith, in his remarks this morning, and I am very grateful to Prof. Smith, from the fact that he does not come from the same alma mater that the geologist did who addressed us yesterday. I am grateful that he takes a different view of this subject than the geologist did.

The one point that I wish to make to you, Mr. Chairman and gentlemen, is this: Mr. Laylin in his specifications for brick road work provides that the brick shall be inspected on the highways. In those specifications he requires that when 10 per cent of the brick are rejected the entire mass of brick *may* be rejected. I want to refer to the argument made by Carlisle here, to the instructive lessons that he gave us in New York, where they handle thousands and thousands of tons of material, how he illustrated that they even went so far as to go to the gravel banks and the stone quarries, and all the various materials were analyzed in advance and passed upon intelligently in advance. It does seem to me that the brick men are moving backward, that the engineers in charge of brick construction are not at least progressing forward, when a material is so simple as a brick, and the construction is so centralized at one point, if they do not insist and the engineers do not insist that the brick should be inspected at the factory. Now, I submit to you gentlemen, the contractor purchases the brick at the factory, purchases them subject to the approval of the engineer. The brick are delivered to the nearest siding which may be six or eight or ten miles from the highway. Those bricks, at very great expense—and the expense is charged to the general public—are hauled and delivered on the highway, and

subject to the approval of the engineer. Eventually, what is the practical result? Those brick are, at some additional and great expense, delivered to the carriers or by hand or by wheelbarrow to the street. They are laid in the street. If the street is sprinkled and the bricks are sprinkled and they are rolled with a roller, all those things are expensive items. Time is going on, expense is accumulating. After the roller has progressed over the work sufficiently, then the inspector starts out with the power to reject the brick and, under the specifications, he may reject not exceeding 10 per cent., and then, if he wants to, he can reject the whole of the brick.

Now, gentlemen, stop and think of it for a moment. Think what a tremendous expense is to be borne by someone—a tremendous waste which is absolutely unnecessary. Isn't it possible, if the highway commissioner of New York can require that the gravel, the crushed stone and those various ingredients that in fact do vary in quality and in kind at the bank, that the brick can be inspected properly at the factory. There is a further reason why they should be, and that was touched upon by the gentleman from New York this morning. The further reason is this: After a brick has once been bedded by the compression of the roller, then that brick has found its bed and its foundation, its base, and that brick should not be taken out except for grave cause and sound reason. (Applause.) Those bricks are bedded in the street, and when you remove a particular brick with a particular kiln mark or a particular shape and substitute in its place another brick with another kiln mark and another shape, you are giving it exactly the same reason to destroy itself in its bed, because a lump of gravel under the corner of the brick will start disintegration. It starts a shattering of the grout which is only a very thin peeling at most. It does occur to me, Mr. Chairman and gentlemen, that the one important thing lacking in our brick specifications today is inspecting at the factory, and I do hope that this great assemblage will take that question up and solve it.

Just one thing more, Mr. Chairman and gentlemen. A suggestion was made as to the contractors in Europe, as to the great personal interest that they take in the work. Now, I want to say that the contractors in Europe are human, like the contractors in the States. We lay brick pavements in Ontario and we lay them all over the country, as well as other pavements. I find human nature is the same everywhere. You pat a fellow on the back and he will break his

neck for you; but you abuse him and he won't. You treat a man kindly and work in harmony with him and he will work his head off for you. You abuse him and he won't. Now, the contractor, like the engineer in this country, has been gradually set aside. He has been gradually pushed off in the corner until today he is the dependent contractor. He is the hired man under the local politician, who gets two or three dollars a day for the inspection. (Applause.) I didn't finish my remarks the other day except as to the engineer. I have stayed by and have seen the engineer gradually put aside by the local politicians, by the saloon-keeper and the fellow who has sufficient pull, for many years, and during all those years the engineer's power has been lessened; during all of the years the power granted to the political inspector has been increased. As to the contractor today, I don't believe there is a specification in the United States that gives the contractor any say whatsoever in the construction of the work. Now, the contractor should honestly be put in an honest position, in an independent position with certain rights. Then he would take the same interest in building your road and your pavement that the engineer would, had he the same power that he used to have many years ago.

These three problems, gentlemen, I think are serious—the engineer graded back into the power and place and position where he belongs, the contractors to go side by side and be graded back into the power and position and place where they belong and the inspection of brick at the factory. I thank you. (Applause.)

MR. BLAIR: I would like to make an explanation, Mr. Chairman. I want to say that so far as the manufacturers of brick in this country are concerned the blame can hardly attach to them for lack of factory inspection. But I am gratified to be able to say that at the last meeting of the American Society of Municipal Improvements—a society that has much to do with specifications in this country—it was conceded that brick should be inspected at the plant. All kinds of manufactured materials up to this time have been conceded that right of inspection, such as steel and iron and almost every product of human invention that goes into construction work. It is true brick has been about the last, but the American Society of Municipal Improvements has taken the matter up, and now many of our states and cities are following that lead, and we hope that brick inspection

hereafter will be substantially and almost wholly at the factory.

MR. LAYLIN: Mr. Chairman, may I have one word?

CHAIRMAN PARKER: You see, Mr. Laylin, we have got something else before dinner.

MR. LAYLIN: This will take just a minute.

CHAIRMAN PARKER: I have been asked to cut the discussion a little bit short, but go ahead.

MR. LAYLIN: The Ohio specifications say that "Sampling may be done at the factory prior to shipment and brick accepted as the result of such sampling will not be rejected as a whole, but will be subject to such culling as may be necessary to meet all of the requirements except that of the rattler test." I will say we have had as many as a dozen inspectors at plants in Ohio. We have them today. The reports are coming in to my desk from the inspectors at the plants. It is becoming more general in Ohio not only to inspect brick at the plant but in many cases cement tests are made from the bins in the cement mills and the bins are sealed. Gravel is tested from the pits. The Ohio specifications for material have resolved themselves almost entirely into a mechanical test. Very, very little is left to the inspector on the work except that of workmanship.

CHAIRMAN PARKER: Now, gentlemen, I am sorry to cut this discussion short, but we have got to do it, because you have now the subject of "Surfaces or Floors for Bridges," which has to come in before the afternoon session, and I believe the discussion of it will have to be put over until the afternoon. Mr. Clifford Older, Bridge Engineer of the Illinois State Highway Commission, will present this subject to you.

MR. CLIFFORD OLDER: Mr. Chairman and gentlemen: As the hour is getting late and this paper was prepared with the idea that I would be able to use slides to show certain curves and prints of our standard bridge floors, the paper loses its punch without the pictures; so I am going to disregard the paper and give you the bald facts contained in this paper in the shortest possible time. I will try to do it in five minutes so that we will all have plenty of time for the afternoon session.

[At this point Mr. Older gave a brief resume of his paper after which the session adjourned. The full text of the paper follows.]

Surfaces or Floors for Bridges

By CLIFFORD OLDER
Bridge Engineer, Illinois State Highway Commission

Definite statistics in regard to the number and length of highway bridges for any considerable mileage of highways are difficult to obtain and are not at present available. In some states, however, we are able to ascertain the amount of the total expenditure for bridge work of all kinds.

Available information of this kind seems to indicate that approximately one-half of the funds raised for ordinary road and bridge purposes are expended in the renewal and maintenance of bridges.

It is evident, therefore, that if maintenance expenditures are to be reduced to the minimum, highway bridges and bridge floors should receive careful consideration.

Judging from conditions in Illinois, it is probable that at least 90 per cent. of all existing highway bridges are provided with nothing better than plank floors, and that the maintenance of these floors costs approximately 15 per cent. of the total expenditure for road and bridge maintenance, or about $10.00 per mile of road per annum.

Floors for New Bridges.—It is a simple matter to provide strength in the design of a new bridge, to accommodate any of the various modern types of floors or wearing surfaces.

It seems desirable to select a type of floor which will permit the use of a wearing surface of the same kind as that on the adjacent highway, so that the same method of maintenance may be used on the bridge floor as elsewhere.

The difference in weight of various types of floors has but little effect on the design and cost of concrete bridges. Steel bridges, however, are materially affected in both design and cost, by a comparatively small variation in the weight of the floor.

The saving in the weight and cost of the steel in the trusses and floor system for the lighter floors may outweigh the advantage of having the same wearing surface on the bridge as elsewhere on the highway.

Floors for steel bridges only will be considered in this discussion.

It is desirable to provide an independent wearing surface so that although the pavement may be worn practically through, the bridge may still carry traffic with safety.

The bridge floor should then preferably consist of two elements.

The sub-floor, which should be as permanent as the bridge superstructure and should provide the necessary strength to transmit the highway loads to the floor supports, and a wearing surface of such character as to permit of economical maintenance.

In considering construction materials for both these elements, the matter of weight increases in importance with the length of span.

. For sub-floors of the more permanent type, buckle plates with concrete covering, reinforced concrete, and creosoted plank cover the field.

For wearing surfaces, brick, concrete, creosoted blocks, macadam, gravel, mixtures of bituminous materials with sand, gravel or stone, plank, ordinary soil and practically all other varieties of surfacing materials have been used.

In comparing costs, it is necessary to consider not only the cost of the floor and its maintenance, but also the effect of the weight of floor selected on the design and cost of the remainder of the bridge.

Classification of Floors With Respect to Weight.—For the purpose of considering the effect of the weight of the floor on the design of the superstructure, the various types of floors are herein grouped in four classes.

Class A Floors: Floors which weigh approximately 100 lbs. per sq. ft. of roadway surface are included in Class A. Floors consisting of a reinforced concrete sub-floor, assumed to weigh 50 lbs. per square ft., on which is placed a wearing surface of concrete, brick, macadam or gravel, are of this class. The wearing surface is assumed also to weigh 50 lbs. per sq. ft. of roadway surface.

Class B Floors: Floors which weigh approximately 65 lbs. per sq. ft. of roadway surface are included in Class B. Floors consisting of a concrete sub-floor, with a creosoted block wearing surface and floors consisting of creosoted plank subfloors with a brick wearing surface, are of this class.

Class C Floors: Floors which weigh approximately 32 lbs. per sq. ft. are included in Class C. Floors consisting of a creosoted plank sub-floor with a creosoted block wearing surface, are included in this class.

Class D Floors: Floors which weigh approximately 26 lbs. per sq. ft. are included in Class D. Floors consisting of a creosoted plank sub-floor with a wearing surface about ¾ in. thick, composed of a mixture of gravel and bituminous material, are of this class.

Buckle plate floors are not considered, as they weigh as much and cost more than concrete sub-floors.

Description of Floors Illustrated.—Figure 1 shows standard designs used by the Illinois Highway Department for the floors above mentioned.

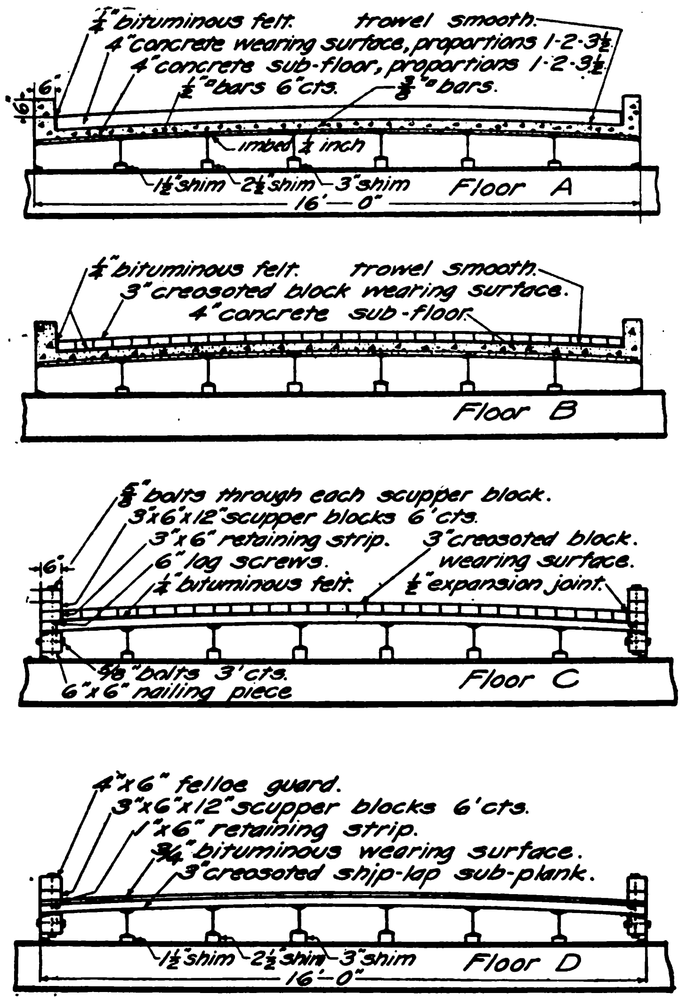


FIG. 1—STANDARD DESIGNS OF THE ILLINOIS STATE HIGHWAY DEPARTMENT FOR BRIDGE FLOORS OF CLASSES A, B, C AND D.

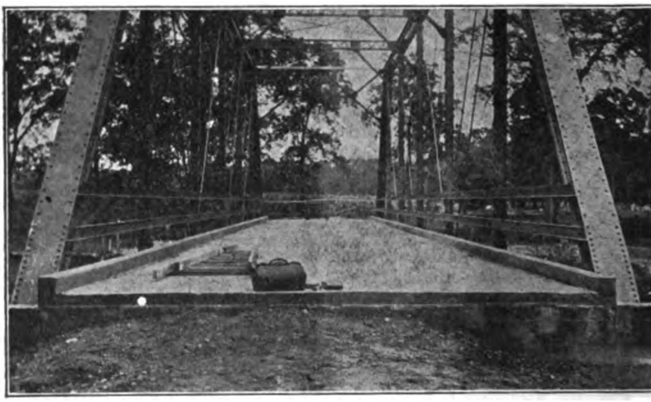
The creosoted plank sub-floors (Floor C and Floor D) are crowned by bending the plank over the stringers and anchoring the ends to the nailers by means of lag screws.

The creosoted blocks (Floor B and Floor C) are laid on a ¼-in. bituminous felt cushion, which is coated with asphalt immediately before laying the blocks.

Ship-lap sub-plank are used for floors having a bituminous gravel wearing surface. The use of this form of sub-plank has been found to be the cheapest and most effective method of preventing the leakage of the bituminous material.

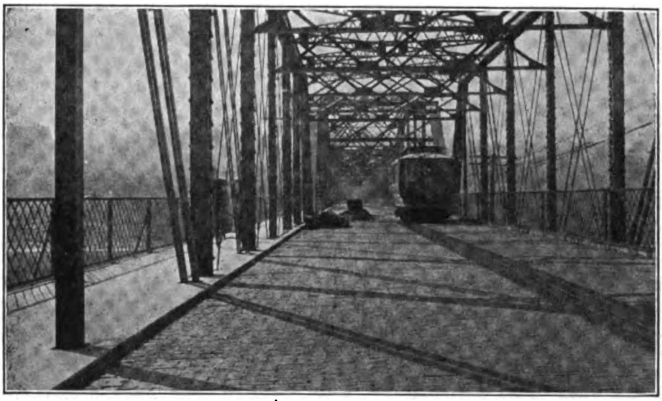
The five illustrations on Pages 158, 159 and 160 show some of these floors on existing bridges.

Explanation of Curves.—The curves (Figure 2) show the weight of the structural steel in bridge superstructures as

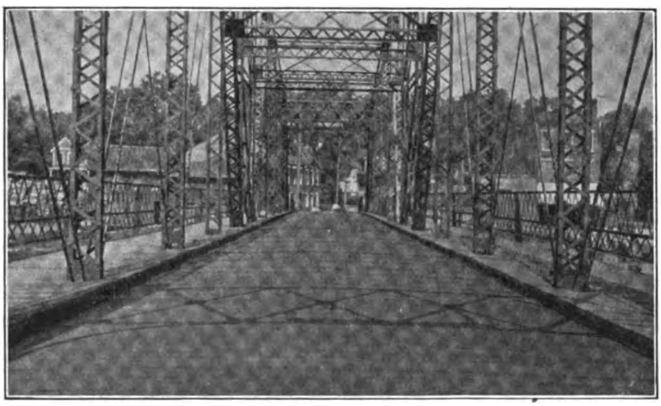


CONCRETE SUB-FLOOR READY FOR THE WEARING SURFACE—ILLINOIS HIGHWAY BRIDGE.

HIGHWAY BRIDGE IN ILLINOIS—CONCRETE SUB-FLOOR WITH MACADAM WEARING SURFACE.



AN ILLINOIS HIGHWAY BRIDGE WITH A CREOSOTED PLANK SUB-FLOOR AND A BRICK PAVEMENT.



AN ILLINOIS HIGHWAY BRIDGE WITH CREOSOTED PLANK SUB-FLOOR, READY FOR WEARING SURFACE.

a percentage of the weight of the steel in superstructures having Class A floors. That is, the weight of superstructure steel in bridges having floors weighing 100 lbs. per sq. ft. is taken as 100 per cent. and the weight of steel required for the lighter floors expressed as a percentage of this weight.

These curves are based on the weight of steel in spans which conform to the standard designs of the Illinois Highway Department. The designs used provide for 16-ft. roadways. The curves were checked at a number of points, however, for 18-ft. roadway designs and were found to conform very closely.

These curves are sufficiently accurate to enable a designer to determine the relative cost of steel superstructures having floors of various types and weights.

The curve (Figure 3) is based on the curves (Figure 2) and shows the average per cent. variation in weight of steel for a variation of 10 lbs. per sq. ft. in the weight of the floor.

Figure 4 shows the average contract price for the Illinois Highway Department standard 16-ft. roadway steel spans with floor complete.

For spans up to 80 ft. inclusive, riveted pony trusses are used. For spans from 90 to 160 ft. riveted Pratt trusses are used. This range of span length covers at least 90 per cent. of the highway bridges in Illinois.

BRIDGE SHOWN IN ILLUSTRATION ABOVE, WITH BITUMINOUS GRAVEL WEARING SURFACE IN PLACE.

The average contract price of materials is as follows:

Structural steel, complete in place.............$.03½ per lb.
Concrete sub-floors, including reinforcing steel..$12.00 per cu. yd.
Concrete wearing surface, 4 ins. thick.........$0.90 per sq. yd
Creosoted sub-plank (12-lb. treatment) complete in place, $70 per thousand feet, board measure.
Creosoted block wearing surface...............$1.80 per sq. yd.
Bituminous gravel wearing surface............$0.60 per sq. yd.

The average cost of sub-floor and wearing surface per foot of 16-ft. wide roadway (1.78 sq. yds. including curbs) is as follows:

Concrete sub-floor with concrete wearing surface (wt. 100 lbs. per sq. ft.)........$4.25 per ft. of bridge
Concrete sub-floor with creosoted block wearing surface (wt. 65 lbs. per sq. ft.).. 5.80 per ft. of bridge
Creosoted plank sub-floor with creosoted block wearing surface (wt. 32 lbs. per sq. ft.) .... 7.30 per ft. of bridge

Creosoted plank sub-floor with bituminous gravel wearing surface (wt. 26 lbs. per sq. ft.) .... 5.15 per ft. of bridge

It seems probable that under average conditions the length of life of the floors represented by the upper three full-line curves may equal that of the remainder of the superstructure and that the cost of maintenance for this period would be small.

The experience of the Illinois Highway Department seems to indicate that under average conditions, the bituminous wearing surface requires a light treatment of oil and stone chips or screened gravel, at intervals of about four years at a cost of about 10 cts. per sq. yd. and a probable complete resurfacing once in about twelve years at a cost of approximately 60 cts. per sq. yd. This amounts to 7½ cts. per sq. yd. per annum.

Adding to the first cost of the bridge, the maintenance charge capitalized at 6 per cent., Curve D_2, Figure 4, results. The position of this curve indicates that it would be preferable to use creosoted block or other floor in building new structures.

Probably 95 per cent. of existing steel highway bridges were originally designed for ordinary plank floors. Under average conditions and at the present price of yellow pine, which is the material now quite generally used, the annual cost of maintaining such floors is about 35 cts. per sq. yd. The first cost, plus the maintenance charge capitalized at 6 per cent., results in Curve E, Figure 4.

Conclusion.—It is evident that ordinary plank floors having an average life of not more than three and one-half years are to be avoided when possible.

It is to be noted that with the exception of the floor with the bituminous surface, the cost of the floor increases as the weight decreases, and yet the cost of the entire superstructure decreases as the weight of floor decreases.

The saving in cost for the lighter floors increases with an increase in the unit cost of structural steel in place, and decreases with an increase in the cost of the materials used in such floors.

In reflooring old steel bridges of satisfactory design, a creosoted sub-plank with bituminous wearing surface has been found to give reasonable service. The weight is somewhat greater than that of a plank floor, but the effect of the

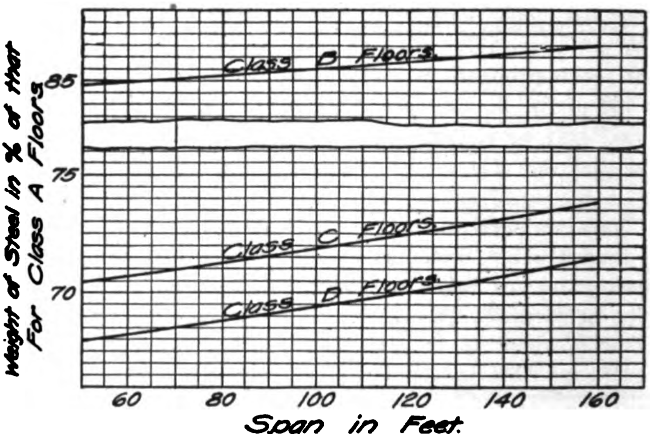


FIGURE 2.

added weight is probably offset by the reduction of impact, due to the comparatively smooth and yielding surface.

The cost of maintaining the bituminous surface is only about 20 per cent. of that of an ordinary plank floor.

There seems to be no place in the economic design of new highway bridges for floors consisting of a creosoted plank sub-floor with a brick wearing surface as the life of such a floor could hardly be greater than that of floor C, Figure 1, while the cost of the complete superstructure would be greater than that represented by Curves B and C, Figure 4.

The floors listed under Class A seem hardly to be justifiable, except for short spans, unless other considerations outweigh first cost.

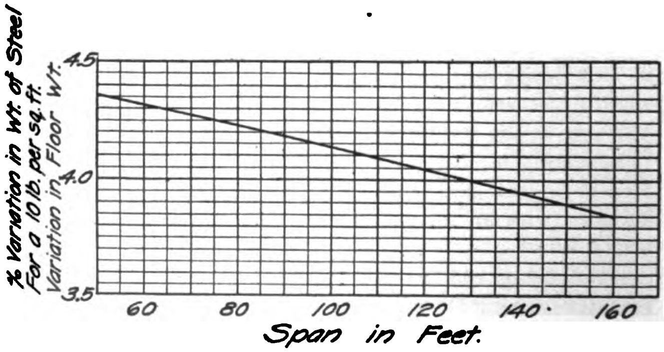


FIGURE 3.

Fifth Session, 2:30 P. M.

PRESIDENT McLEAN: Gentlemen, please come to order; the time has come for opening our afternoon session. The discussion of the last paper, on bridge floors, will be the first matter taken up this afternoon, and I will ask Mr. John R.

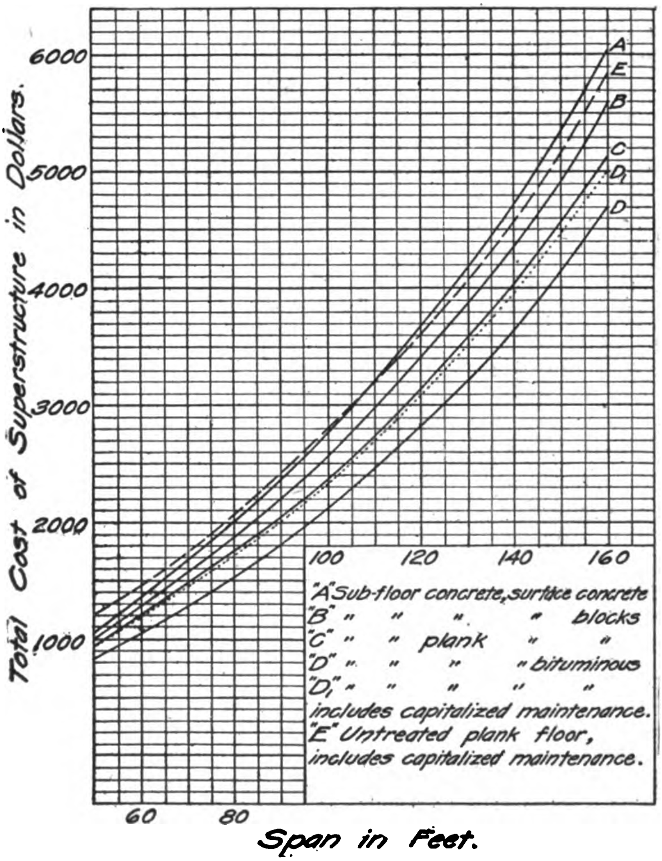


FIGURE 4.

Chamberlin, Deputy in Charge of Bridges, Ohio State Highway Department, to open the discussion. Mr. Chamberlin.

JOHN R. CHAMBERLIN (Deputy in Charge of Bridges, Ohio State Highway Department): There can be no question but that the bridge floor problem is of sufficient

magnitude to justify more attention than it ordinarily receives. Taking Mr. Older's conservative figure of ten dollars per mile for the annual cost of maintaining bridge floors, we have for Ohio $837,000, or nearly one million dollars. In many localities the lines of least resistance are followed, though, I believe, much progress has been made during the past five years.

Mr. Older mentions the desirability of using a wearing surface on bridges the same as the adjacent roadway, so that the same methods of maintenance may be used. His figures, however, in the case of steel bridges, show us a balance of cost in favor of other types of floors. This balance must be compared with any advantages we may gain in using a bridge carrying road metal similar to the adjacent roadway.

I desire to call attention to conditions other than the convenience of maintenance, which to me seem in favor of a concrete sub-floor carrying road metal, as compared with a plank floor carrying wood block: 1. Its rigidity; 2. Its weight or inertia; 3. Its tendency to absorb impact; 4. Its greater efficiency in distributing concentrated loads; 5. Its concontinuity with the roadway.

Because of its rigidity, a bridge is less racked by a moving load; that is, there are less secondary stresses in riveted trusses, and less vibration due to movement of the load. A concrete sub-floor is a valuable adjunct in resisting wind stresses and stresses due to high water with accompanying floating drift. In short spans it affords ample lateral bracing without a special lateral system.

Because of its weight, reversal of stresses is reduced in amount. It is less liable to be dislodged by high water. In case the common unit of stress of 16,000 pounds is used in the design, the large ratio of dead load to total load gives an additional factor of safety. With increasing dead load the effect of impact becomes less. Some formulae recognize this in fixing the required impact stresses. Furthermore, a layer of macadam, or a brick pavement on a sand cushion is capable of absorbing shock. Such floors offer both weight and cushion, two important factors tending to minimize impact stresses.

The design of a joist is generally governed by a concentrated load. The portion of this load carried by each joist depends upon the flexibility of the sub-floor, therefore, since plank are more flexible than a concrete slab, the individual joists must be proportioned to receive a larger live load, or

otherwise the same joists may be spaced farther apart with a concrete slab than with plank. Tests have verified this.

It is a matter of common observation that a depression is formed at each end of the bridge due to the hammer blow of wheels passing from one kind of surface material to another, the action being similar to that producing low joints on a railway. Such depressions, like low joints, grow more pronounced and demand continuous attention. This difficulty practically disappears if the pavement is continuous.

Regarding the first cost of Types A and C, as shown in Fig. 4, I beg to present a similar comparison based upon plans of the Ohio State Highway Department, figured at the following representative unit prices: Structural steel, 3¼ cts. a pound; reinforcing steel, 2¼ cts. a pound; concrete for floor, $10 per cu. yd.; brick laid on sand cushion, $1.10 per sq. yd.; creosoted lumber, $65 per M; creosoted wood block laid, $2.25 per sq. yd.

The following table shows the relative costs for various span lengths, 18 ft. roadway, for Type A, using brick floor, and Type C as described:

	Lbs. Struc. Steel		Cost		Diff.	C in
Span.	A	C	A	C	in cost.	% of A
60	38,000	39,000	$1,859	$2,017	$158	109
80	53,000	54,000	2,558	2,758	200	108
120	101,000	96,400	4,649	4,742	93	102
140	147,000	121,000	6,516	5,818	698	89

The first two are of low Warren type and the last two high Pratt trusses.

The most important points of this comparison are: First, that Type A is cheaper, up to and including the 120-ft. span; second, that the difference in cost is much greater at 140 ft. than at either of the three other lengths, both in actual difference and in per cent. In other words, the difference in cost becomes more important in the larger spans than in the shorter. Third, while the dead load is, of course, greater in Class A, there is actually less structural steel required than in Class C. This is brought about by the two factors heretofore discussed, that is, impact and distribution, permitting a saving on joists. Impact stresses are for light floors obtained by the quite common formula:

$$I = \frac{100}{L + 300} \times \text{the live load stress, where L is the length}$$

of loaded section. This amounts to approximately one-third of the wheel load, of 10,000 lbs., one-third of a 15-ton roller.

Impact for Class A is arbitrarily taken as one-half of that for Class C. Some specifications neglect impact entirely with concrete floors. This difference in impact of one-sixth wheel load reduces to an equivalent of about 60 lbs. per sq. ft. for average panel lengths and joist spacings, amounting to nearly the total difference in dead load taken by Mr. Older. This reduction of impact also applies to the design of the trusses.

A rule not covered in specifications, but deduced from experiment, is used in proportioning joists as follows: With plank sub-floor, a wheel load is assumed to distribute equally over a distance of 4 ft., with concrete slab, 6 ft. In other words, joists spaced 2 ft. will bear one-half of a wheel load if plank, and one-third of a wheel load if concrete slab.

These two conditions actually contribute enough saving of steel in the joist to more than compensate for the extra metal in trusses due to a heavier type of floor. Still further opportunity is offered for saving structural steel in case of a low truss by using the subdivided Warren type, thus reducing panel lengths to 8 or 9 ft. and laying a continuous slab over the floor beams. This design, however, is not used in the above comparison, though it may be built at less cost, if cost is based upon unit prices mentioned.

Another point to be remembered is that for short span high trusses, minimum values of L/R, minimum thickness of metal, and requirements for floor beam connections, are likely to fix the size of posts rather than actual stresses. If so, Class C has no advantage over Class A in these numbers.

In comparing our observations with those of Mr. Older, it will be noted that our chief difference applies to bridges whose span is short, less than approximately 120 ft. For longer spans we believe Class C more economical than Class A and there is less demand for a heavy floor to provide rigidity and inertia, and lessen impact, and the question of continuity of roadway becomes less important.

In Fig. 1 of Mr. Older's paper, Floor A is shown with concrete sub-floor and concrete wearing surface, each 4 ins. thick. It is provided that the first course be troweled smooth before the second is applied. Of course, the idea is to have a plane of separation looking to the time when repairs become necessary. The only question is whether to trowel smooth is sufficient. The idea of separation of courses is ignored by some who contend that when a con-

crete wearing surface is laid it should be permanent. Many floors are in service with travel directly on the slab. Such floors have a two-fold duty, to bear the weight and resist the wear. To subject a concrete slab to wear when the strength of the structure depends upon its thickness seems wrong. It would seem wise to have some plan of repair in mind when building. It would also seem proper to provide some means of warning to announce the time when repairs are imperative. A small bridge with a concrete wearing surface, built some four years ago, when inspected recently showed ruts about 1½ in. deep. The roadway is a narrow gravel macadam, directing the travel over the bridge, so that there is little deviation from a single beaten path. The engineer under whom the work was done states that the concrete was inferior, although he did not see it placed nor was there any inspector present. The mix was supposed to have been 1:2:2. The concrete shows no defects other than the ruts, which are quite smooth. This case is described to warn those who believe there is no wear to concrete floors. I thank you. (Applause.)

PRESIDENT McLEAN: The discussion on this paper will be continued by Mr. E. A. Byrne, of the Department of Bridges of New York City. Mr. Byrne. (Applause.)

E. A. BYRNE (Assistant Chief Engineer, Department of Bridges, New York City): To this paper of Mr. Older's, which has been so ably discussed by Mr. Chamberlin, I don't think I can add anything further. Both the paper and the discussion appeal to state engineers rather than to city engineers, to which my work has been confined. I would like to say a few words, however, about the troubles we have; in fact, I have written a short paper here on the problems that the Department of Bridges has to deal with in the design and maintenance of roadway pavements on the 42 bridges that it has under its jurisdiction. Most of these bridges are movable bridges, except the large ones across the East River, four in number, one across the branch of the East River, and outside of that a few small wooden bridges. The balance of about 35 are all movable bridges, and the conditions to which Mr. Older calls attention and which are also discussed by Mr. Chamberlin do not interest me as they do state engineers. If you would like to hear this paper and if you will bear with me for a while I would like to tell the troubles that we are experiencing on some of our large bridges, especially the Queensboro, the Williamsburgh and the Brooklyn Bridges.

One of the most serious problems that the Bridge Department of the City of New York has to deal with is the design and the maintenance of the roadway pavements on the 42 bridges it has under its jurisdiction. Of these the Queensboro, Williamsburg and Brooklyn are now demanding our close attention, and we hope to correct the conditions which now exist. Each bridge presents its own particular defects and they require careful study and much experimental work.

It has been my good fortune to study these three bridges at first hand during the past two years and suggest designs that have been adopted and to have had experimental sections of pavement actually laid that have shown to us satisfactory results.

I will discuss at first the pavement of the Queensboro Bridge, as the conditions there have caused much inconvenience to the traveling public and much anxiety to us.

The roadway pavement of this bridge consists generally of treated wood blocks on a Portland cement concrete foundation. This foundation rests on different bases at various sections of the structure. On one approach the base is of reinforced concrete, which in turn supports a waterproofing protected by common brick on which the pavement foundation is laid with a thickness of 6 ins. On part of other approach the concrete foundation, 6 ins. thick, rests on earth fill and part on buckle plate floor. On the main bridge buckle plates support the concrete foundation.

The length of the approach on reinforced concrete is	1,052 ft. 0 ins.
The length of the approach on earth fill is	436 " 2½ "
The length of the approach on buckle plates is	2,236 " 0 ins.
The length of the main bridge on buckle plates is	3,724 " 6 "
The total length of bridge is......	7,448 ft. 8½ ins.

The width of roadway is 52 ft. 3 ins., which means an area of 43,240 sq. yds. of wood block pavement to be maintained. The pavement laid on reinforced concrete and on earth fill, amounting to 8,640 sq. yds., has not required any repair from the time the roadway was opened to traffic on March 30, 1909. The part laid on buckle plates, 34,600 sq. yds., has been a source of constant trouble during the past two and one-half years.

The design of the roadway floor where buckle plates are used called for the placing of these plates on stringers, having

a top flange width of 12 ins., spaced 5 ft. on centers, the plates being laid with the buckle down. On this floor a Portland cement concrete base (1:3:6) was laid. The depth of this foundation, for the greater part of the roadway, varied from 1½ to 4½ ins. On this concrete a cushion of very dry cement and sand mortar ½ in. in depth was spread and its surface struck with a straightedge. On this cushion the wood blocks were laid at right angles to the center line of the bridge with ⅛-in. joints.

The blocks were 4 ins. in depth and cut from sound long leaf yellow pine planks 4 ins. thick and from 7 to 9 ins. wide. Ten per cent. sap wood was permitted.

The blocks were treated by the creo-resinate process and the usual tests were specified.

The joints were filled with paving cement of a bituminous material, free from coal tar or its products.

For the first two years of service this pavement required but slight attention, but the constantly increasing traffic commenced to affect the foundation quite seriously. The buckle plates, under the heavy traffic, continually deflecting, caused the concrete to crack at many points. As the stringers provided a more rigid base, the concrete over them stood up much better.

The concrete used was of very lean proportions for use under such conditions, and it might be justly stated as a further cause why this pavement should fail.

It is quite remarkable to see how this pavement maintains its almost original position over the stringers and assumes a depressed surface, varying from ¾ in. to 1½ ins. over the center of the buckle plates, forming a series of well-defined ridges and valleys over the entire length of the bridge where these buckle plates form the base.

The sand and cement mortar cushion has also been a source of trouble.

This cushion, for lack of ability to drain, is always damp and after storms it is thoroughly saturated. When these storms are followed by rapid changes in temperature, the blocks commence to heave and this heaving in many places has amounted to over 3 ft. above the normal surface of the pavement. This cushion provides a shifting base for the blocks and this, together with the expansion and contraction of the bridge, further accelerates the movement of the pavement. On one or two occasions vehicle traffic over the bridge had to be confined to the spaces occupied by the trolley tracks to avoid possible

accident. There are two trolley tracks laid on this bridge within the pavement limits, each located near the curb.

In the fall of 1912 I designed a new foundation, with the view of correcting this condition. In any design it was of first importance that no increase in the weight of the floor be made, as that of necessity would reduce the live load capacity of the structure. The buckle plates could not be replaced on account of the rigidity they added to the general stability of the bridge.

The design in general consists essentially of a parquet foundation, formed by a combination of timber planking and Portland cement concrete, with the creosoted wood blocks laid directly on this foundation, without a cushion.

The timber used was 3x12-in. long leaf yellow pine—merchantable inspection—dressed to an even thickness of 2½ ins. These planks were laid flat and bolted to each line of stringers by machine bolts spaced 30 ins. apart. The heads of the bolts were finished flush with the top of the plank and the countersunk hole around the head was filled with Portland cement mortar. Planks were similarly bolted to each floor beam, with the result that a trough was formed, timber at vertical faces and the buckle plates forming its bottom. This space was filled with a Portland cement concrete (1:2:4), the top of which was finished smooth at the top of the 2½-in. timber plank.

The holes in the invert of the buckle plates were used for drainage, by the placing of galvanized iron thimbles in them, which extended to within a point just below the finished top of the concrete.

On this composite foundation creosoted wood blocks were laid with sand joints and, as stated before, without a cushion.

These blocks were 3 ins. in depth and cut from 3x8-in. long leaf yellow pine timber.

It was to be expected that the blocks, resting as they do, partly on timber and partly on concrete, would splinter. This they have done in places, but there has been no heaving of blocks in the various experimental sections laid to date. These sections are standing up well under the traffic. The cost has averaged $4 per sq. yd.; this, I believe, can be reduced 10 to 15 per cent. for a large area.

In the reconstruction of the entire pavement it is proposed to check the longitudinal movement of the pavement by the installation of transverse angles at each floor beam. These were not provided in the original design and the longitudinal movement of the blocks has been quite noticeable.

I do not care to take up too much time with statistics, but I believe the traffic count of vehicles taken during the years 1909 to 1914 would be of interest, as it shows a most remarkable increase of this class of traffic.

In 1909 the daily average was	1,170
In 1910 the daily average was	2,110
In 1911 the daily average was	2,190
In 1912 the daily average was	3,640
In 1913 the daily average was	6,570
In 1914, May, the daily average was	7,500
In 1914, June, the daily average was	8,760

I will now refer to the Williamsburg Bridge and explain the conditions there and what we have done in an attempt to correct them. This structure, which was opened to vehicle traffic in December, 1903, is a suspension bridge, having two roadways, each 20 ft. in width. The main bridge is 2,793 ft. in length from anchorage to anchorage, and the two approaches have a combined length of 4,515 ft., making a total length of bridge of 7,308 ft., which means an area of 32,480 sq. yds. of pavement to be maintained.

The approaches are paved with Medina (N. Y.) sandstone blocks on a Portland cement concrete foundation (1:2¼:4½). This foundation varies in depth according to the different bases on which it rests. On the earth fill it is 6 ins. in thickness; on buckle plates, with buckles up, it varies from 4 to 7 ins., and on the corrugated trough plates from 3¼ to 12 ins.

This pavement, of which there are 20,065 sq. yds., has worn very rapidly. The Medina block is a very soft stone and the blocks at and near the curb have shown a reduction in depth of 4 ins., due to wear. The specifications for these blocks required a thickness of not less than 4, nor more than 5 ins., a depth of not less than 6, nor more than 6¼ ins., and a length of from 7 to 12 ins. The department, when making repairs, has substituted a granite block for the Medina.

The main bridge is paved with creo-resinate long leaf yellow pine blocks, 4 ins. in depth and cut from 4x8-in. planks. These blocks are laid at right angles to the center line of the bridge and rest on 12-in., 20½-lb. channels, laid longitudinally with the bridge, with a space of ½ in. between channels, the web horizontal and the flanges turned down. These flanges rest directly on 7-in. channels laid transversely on 30-in. centers. The tops of the 12-in. channels were given a coat of hot asphaltic cement and the blocks were laid on this cement with close joints filled with an asphaltic and coal tar compound.

In 1909 these channels commenced to show signs of failure, the webs under the heavily increasing traffic deflected badly, and in many cases this continued deflection caused fracture, necessitating the replacement of 118 of these channels to date.

The failure of these channels under traffic was a very serious matter, and much thought has been given to the many designs that were suggested.

Here, as at Queensboro, it was again a question of weight of floor. (The present pavement, including channel base, weighs 46 lbs. per sq. ft.) The plan which seemed to offer less inconvenience to the traveling public, as well as being less expensive, consisted of laying a timber floor on the top of channels and the use of a shallow paving block.

In 1913 an experimental section, in accordance with this plan, was laid on one of the roadways, in which five different classes of blocks were used. The design consists of laying long leaf yellow pine plank, dressed on sides and edges to a uniform size of 2½x3¾ ins., on the channel floor, from curb to curb in one length, and bolted to the channels by two ½-in. bolts at every alternate one. The plank is untreated, but before the blocks were laid the top surface was coated with paving pitch. The section was divided by transverse angles into five equal spaces. In these spaces were laid, as stated before, five kinds of blocks, as follows: Creosoted wood blocks 2 ins. deep, cut from 1⅞x8-in. plank; untreated wood blocks 2 ins. deep, cut from 2x8-in. plank; cork asphaltum blocks 2 ins. deep, 3¾ ins. wide and 8 ins. long; untreated wood blocks 2½ ins. deep, cut from 2½x8-in. plank, and creosoted wood blocks 2½ ins. deep cut from 2½x8-in. plank. All the wood blocks are of long leaf yellow pine, purchased on the following specifications of the Bridge Department of the City of New York:

The timber from which the wood blocks are to be made shall be Southern long leaf yellow pine, and is to be subject to inspection at the works in the stick before being sawed into blocks.

The blocks shall be cut from the above specified lumber, which must be sound, long leaf yellow pine, well manufactured, full size and saw-butted, and shall be free from the following defects: Unsound, loose and hollow knots, worm holes and knot holes, through shakes or round shakes that show on the surface. The blocks shall be square edge and shall show two-thirds heart on both sides, or equal to two-thirds heart on entire surface of plank from which blocks are manufactured. Blocks will not be accepted, that show full heart at or near centre of same. The annual rings shall average not less than eight (8) to the inch, and shall in no case be less than six (6) to the inch, measured radially.

The cork asphaltum pavement blocks did not prove satisfactory, and it was finally decided to use the treated blocks 2¼ ins. deep, cut from 2x6-in. yellow pine planks. This pavement, including the planking, weighs 46½ lbs. per sq. ft. The

untreated blocks have also shown very well, but it was not thought advisable to use them until we had further tried them out. I might state that the untreated blocks just before being laid were immersed in tubs of water at the site, and they have not heaved or swelled since being laid.

The increase in the vehicle traffic on this bridge since its opening has amounted to over 250 per cent. In 1904 the daily average was 2,026, and in 1913 the daily average was 7,417.

I will now discuss the Brooklyn Bridge, and wish to call your attention to what we are doing with a view of decreasing the excessive cost of maintaining the roadway pavements of this structure.

The bridge has two roadways, each 16 ft. 9 ins. in width, and a trolley track is laid on each of them near the inner curb; this arrangement permits of the passing of but a single line of vehicles. This concentration of traffic tends to wear out the pavement very rapidly.

The main bridge is 3,455 ft. 6 ins. in length, and the two approaches 2,550 ft. 6 ins. in length, a total length of 6,006 ft.

The pavement of the main bridge consists of 2½x10-in. spruce plank, laid transversely on 3½-in. to 5-in. creosoted yellow pine timber, laid longitudinally. This underflooring is carried on steel cross beams. The daily traffic averages 4,000 vehicles, and this necessitates the renewal of the spruce planking twice during the year. The planking on the up grade averages four months' wear, while that on the down grade averages six months, and that on the part near the center, which is nearly level, averages eight months.

Here again the question of weight was of vital importance, and any change in design had to provide that the dead load on the structure should not be increased. The present pavement weighs only 25 lbs. per sq. ft.

It was finally decided to lay several sections of wood blocks and cork asphaltum blocks on an underflooring of untreated yellow pine timber. The cork asphaltum blocks failed completely and they have been replaced by wood blocks.

The wood blocks all were 2½ ins. deep. The creosoted blocks were cut from 3x8-in. planks; the untreated yellow pine blocks from 2½x10-in. planks, and the spruce from plank of the same size. The creosoted blocks have given the most satisfactory results, and we expect to pave the main bridge with this kind of block. This pavement weighs 26½ lbs. per sq. ft.

The pavement of the approaches consists of granite blocks on Portland cement concrete foundation. In relaying this pavement, granite blocks 5 ins. in depth were used, laid on a

1-in. sand cushion with cement grout joints. The blocks removed were 8 ins. in depth on a 2-in. cushion with tar and gravel joints. The foundation of the old blocks was in good condition and was not removed, but an additional layer of concrete was laid on top of the old foundation, so that the new blocks when laid would be at the old grade.

In connection with this repaving, I designed a cast iron and concrete block to be laid along the curb. Most of the vehicles crossing the bridge use the curb for a brake, and consequently the blocks along the curb wear out before the balance of the pavement. This wearing of the blocks was also quite irregular, producing a series of ridges and depressions which interfered with the speed of the movement of the vehicles, as well as causing severe jolting of their springs. These blocks required frequent repair, and where traffic is so concentrated these repairs were of great annoyance to the traveling public.

The cast iron and concrete blocks have proved satisfactory and their cost has fully justified their use. The blocks are of cast iron 6 ins. deep and 4½ ins. wide, and are made in two lengths, one 5 ins. long and one 10 ins. long. These blocks are cast hollow with a top face 1⅛ ins. thick. They may be best described as an open box or crate, having ends and bases of ¾-in. square metal. Recesses are cast in the top face to prevent slipping. The hollow space is filled with Portland cement concrete (1:2:4), which is thoroughly set before the block is placed in position in the pavement. The blocks are laid in conjunction with the granite blocks, with which they bond with a lap joint of 5 ins. In order to decrease the cost of the block I have reduced the length of the 10-in. block to 8 ins.

The Manhattan Bridge is the last of the four great East River bridges to be opened to the public, and our pavement troubles have not as yet commenced on this structure.

Before turning to the smaller bridges of the Department, I think it would be of interest to mention the great amount of traffic these four bridges accommodate. From a traffic count taken October 30, 1913, these four bridges carried:

10,128	Elevated Railroad Cars
21,364	Surface Railway Cars
24,251	Vehicles
314,797	Elevated Railroad Passengers
365,185	Surface Railway Passengers
47,558	Passengers in Vehicles
15,452	Pedestrians
742,992	Total people crossing bridges

This shows an increase of 12.6 per cent. over 1912 traffic. which in turn was an increase of 4.7 per cent. over 1911.

In addition to the four East River bridges, the department

has under its jurisdiction 38 smaller bridges, which have cost the City of New York over $37,000,000 to construct. The sum includes the cost of land taken for bridge purposes.

The policy of the department has been to replace all the various types of pavements, with the exception of granite block and wood block, and to eliminate the use of Medina block, sheet asphalt, asphalt block, plank and macadam, which together with granite and wood block constitute the various kinds of pavements in use on the city's bridges.

The original cost of the wearing surfaces of all the bridges of the department is less than 1 per cent. of the cost of construction of these bridges, and although the city authorities have expended money for the construction of bridges it has been quite a difficult matter to have them appropriate funds for repavement purposes, and consequently it is only on the smaller bridges that progress along this line has been made.

The first bridge in the department where the pavement was entirely reconstructed was the Meeker Avenue Bridge over Newtown Creek, a branch of the East River.

The bridge cost the city $142,500. It was built in 1890, and in 1903 its roadway pavement, which consisted of 3-in. yellow pine plank on a base of similar material, was replaced by a wood block pavement.

The plans for this work were prepared by me and the work was done under my direction. It was the first bridge in New York City where wood blocks were used. Since this pavement was laid in 1903—eleven years ago—it has not required any repairs and has not cost the city one cent for its maintenance.

The bridge is a center bearing draw span 200 ft. in length and has two steel approaches having a length of 85 ft., making a total length of bridge of 285 ft. The roadway is 20 ft. wide. It accommodates an average daily traffic of 900 vehicles.

I believe it would be of interest to state how this pavement was laid. All the old timber was removed and the steel work was thoroughly cleaned and painted. On the stringers was laid a sub-base of 3x12-in. *untreated* long leaf yellow pine, dressed on sides and edges to 2¾x11¾-ins. This planking was bolted to the steel stringers by ½-in. hook bolts and spiked to four lines of wooden stringers, which in turn were bolted to the steel stringers. On the flooring was laid a waterproof course, consisting of four layers of single-ply roofing felt, tarred to each other and on top, *but not tarred to the flooring.*

This waterproofing was laid with the ends turned up at the curbs and at the ends of the draw and approach spans, so as

to form a trough or pan. On this waterproof course were laid the wood blocks—3 ins. in depth, cut from 2½x6-in. plank. These blocks were long leaf yellow pine and were treated by the creo-resinate process. They were laid at right angles to the traffic, with close joints.

After the blocks were laid, coal tar was poured on them and squeegeed into the joints, ½ gal of coal tar being used per sq. yd. of pavement. A layer of white beach sand, which had been artificially dried, was spread on the blocks and broomed into the joints until they were completely filled. The under side of the sub-base was painted one coat of graphite paint.

The pavement has worn remarkably well. About 10 per cent. of the blocks have splintered, but they have never heaved up or shown any signs of swelling.

The waterproof course is perfect and the steel structure under the pavement is always clean. All the work, with the exception of the waterproofing, was done by department mechanics, at a total cost of $3.75 per sq. yd., including sub-base and waterproofing.

On five other bridges (Metropolitan Avenue, Washington Avenue, Strong's Causeway, Little Neck, 3d Street) in the department, wood block has replaced wood plank.

On four bridges (Vernon Avenue, Willis Avenue, University Heights, City Island) wood block has replaced asphalt.

Two old structures which had wood plank for pavements have been rebuilt and wood block has been used as pavement.

We have two of the ten bascule bridges (Hunters Point Avenue, 3d Street) paved with wood blocks, including their movable spans.

In the design of new bridges I am of the opinion that when weight is the factor, wood block on a timber base is the most satisfactory pavement that can be used—where the conditions permit of the use of a heavy material, granite block is the most preferable. We have had most satisfactory results with untreated yellow pine timber as a sub-base with a waterproof course of felt, and equally good result with creosoted yellow pine timber without this waterproofing course,

Where the design calls for a wood block pavement on a timber floor, the following is suggested as a specification which will give a satisfactory result:

The sub-base shall be of untreated long leaf yellow pine timber of prime inspection, dressed on sides and edges to a uniform size, laid with close joints and fastened to the supporting stringers by means of screw bolts ⅝ in. in diameter, so spaced that every course of planking shall be bolted at each supporting stringer by two bolts. The heads of bolts shall

finish flush with top of timber, have flat wrought-iron washers under head, and at the end have wrought-iron clips, shaped to the form of the top flange of the supporting stringer. Lock nuts shall be provided for each bolt.

The countersunk bolt holes, after bolts have been fastened, shall be flushed with cement mortar, affording an even surface on which to lay the wood block pavement. On this untreated flooring there shall be laid four layers of single-ply felt, tarred to each other and on top.

The wood blocks to be not over 3 ins. in depth and cut from plank not over 3 ins. thick and 8 ins. wide. The blocks to be laid with close joints at right angles to the center line of the bridge, with each longitudinal joint broken by a lap not greater than one-half the length of the block.

After the blocks have been laid, coal tar or paving pitch shall be brushed into all joints in the proportion of ½ gal. per sq. yd. of pavement. This quantity to be used with 3-in. blocks; proportionate amount when blocks are of less depth.

Immediately following the brushing of the tar or pitch, fine beach sand, which has been artificially heated, shall be thoroughly brushed into the joints, filling these joints completely. On top of the pavement there shall be laid a layer of fine brown sand ½ in. in depth.

It is quite important that the drainage outlets be designed and located so that they will actually drain the surface of the pavement.

Transverse angles to arrest movement of the blocks under traffic should be placed at points most suitable to the conditions. The spacing will depend on the amount of traffic and design of the structure.

These angles should rest on the supporting stringers, to which they should be bolted, and the vertical legs shall finish ½ in. below the surface of the pavement.

In plans that call for the placing of trolley tracks within the roadway limits, the details should be so designed that the rails can be installed and maintained with the least possible interference with the pavement.

This has been done at two of the department bridges where wood blocks are used. At one (Vernon Avenue Bridge) the rails can be removed without any interference with the pavement; the rail bonds can also be replaced in like manner. At another (Borden Avenue Bridge) the tracks can be renewed with the removal of less than one-third of the area of the pavement that generally is necessary in work of this kind.

We have been able to do this by supporting the rails on the

steel underflooring independent of the timber sub-base of the pavement and by laying longitudinally two courses of wood blocks along each side of the four rails.

You will observe that I have refrained from stating in detail the cost of repair of the several types of pavement, and I do so for the reason that the traffic conditions and the labor market are factors that tend to keep this cost in New York City far in excess of other localities.

I have endeavored only to explain the conditions that confront the Department of Bridges of the City of New York and what we are trying to do in the way of correcting them.

PRESIDENT McLEAN: As we have trespassed on our time this afternoon in order to dispose of the discussion on bridge floors, I believe that you will agree with me that further discussion from the floor is perhaps not advisable. I will ask that the afternoon's program be now proceeded with as shown in the printed program.

The first paper is on "Bituminous Construction and Maintenance—Recent Practice," by William D. Uhler, Principal Assistant Engineer of the Bureau of Highways and Street Cleaning, Philadelphia, Pa. Mr. Uhler. (Applause.)

Bituminous Construction and Maintenance—Recent Practice

By WILLIAM D. UHLER

Principal Assistant Engineer, Bureau of Highways and Street Cleaning, Philadelphia, Pa.

The discussion of this subject is intended to outline the main features of construction and maintenance of bituminous pavements in the city of Philadelphia, to describe the method of carrying out the specifications and to call attention particularly to the conditions confronting us in present-day bituminous construction, which must be overcome to secure the desired results.

Many perplexing problems arise in the construction of bituminous pavements, especially on streets occupied by railway tracks, where many failures occur alongside and between the rails, due, in most cities, to old agreements, contracts, etc., which prevent the authorities from compelling the railway companies to reconstruct their tracks in accordance with present-day standards. For instance, in Philadelphia, with few exceptions, practically all of the trolley tracks are ballasted with the natural soil, which is a sandy loam. This not being a rigid construction, there is more or less movement of the rails which damages the pavement. The ideal construction, from the standpoint of the paving, is to place concrete under the ties, and it is

usually found advisable, as well as more economical, to place runners of at least one row of blocks on either side of the rails to take the shock and extra wear caused by heavy traffic turning on and off the tracks. There is a difference of opinion among engineers as to the character of blocks best suited for this purpose—scoria, vitrified, wood and granite blocks are used largely—but experience indicates that the most satisfactory results are obtained from the use of closely fitted granite block runners, bedded in the green concrete, and well grouted.

Philadelphia's specifications for sheet asphalt are substantially the same as those adopted by the Association for Standardizing Paving Specifications, at Pittsburgh, in 1913. The country road bituminous specifications include the so-called patented pavements—Amiesite, Filbertine and Warrenite—and a bituminous concrete somewhat similar to the Topeka mixture. Each bidder can bid on only one type of pavement, and the work is awarded to the lowest bidder, irrespective of the type bid on, the pavements being in competition with one another.

The following are abstracts from these specifications, which show the mineral aggregate and the percentage of bitumen used in each pavement.

Amiesite

The mineral aggregate shall be clean, crushed trap rock of approved quality, the maximum to pass a 1¼-in. ring, and so graded as to produce the densest mixture. The mineral aggregate shall be treated with a liquefier to make the asphalt adhere. The asphalt, heated to about 275° F., shall then be added, and after the mineral aggregate is thoroughly coated, oxide of lime shall be added. The ingredients referred to above shall be mixed by weight in the following proportions:

Mineral aggregate	92 per cent.
Asphalt	5 per cent.
Lime	1½ per cent.
Liquefier	1½ per cent.

Filbertine

The mineral aggregate in the Filbertine mixture shall be within the following proportions best suited to make the densest mixture:

¾-in. stone, hard crushed	55 to 65 per cent.
Sand, coarse to fine	35 to 45 per cent.
Mineral dust	4 to 6 per cent.
Asphalt cement	6 to 8 per cent.

Warrenite

The stone, with or without the addition of sand, graded in the following proportions so as to give the wearing surface the greatest degree of density, rigidity, inherent stability and freedom from voids:

Material passing 1¼-in. screen and retained on a No. 8 sieve	40 to 60 per cent.
Material passing No. 8 sieve and retained on a No. 4 sieve	10 to 20 per cent.
Material passing No. 4 sieve and retained on a No. 10 sieve	10 to 5 per cent.
Material passing a No. 10 sieve and retained on a No. 30 sieve	10 to 5 per cent.
Material passing a No. 80 sieve, at least 25% of which will pass a No. 200 sieve	10 to 5 per cent.

The balance to pass a No. 30 sieve and be retained on a No. 80 sieve.

From 5 to 10 per cent. of Warrenite cement as directed sufficient in quantity to coat each particle and fill the voids remaining between the stones.

Bituminous Concrete Specification

The finished pavement shall contain between 8 per cent. and 9 per cent. of bitumen, depending upon its composition, but in all cases, sufficient asphaltic cement shall be used to thoroughly coat all the particles of the mineral aggregate. Fine mineral aggregate shall be proportioned by weight as follows:

Portland cement or stone dust passing No. 200 sieve	0 to 15 per cent.
Sand, passing No. 80 sieve	18 to 36 per cent.
Sand, passing No. 40 sieve	20 to 40 per cent.
Sand, passing No. 10 sieve	8 to 25 per cent.
Sand, passing No. 4 sieve	Up to 10 per cent.

With this fine graded aggregate, there shall be used a proportion of clean, hard limestone with a coefficient of wear of not less than 10, or trap rock chips with a coefficient of wear of not less than 15, all of which will pass a ½-in. screen and be retained on a No. 10 screen, amounting to approximately 25 per cent. of the whole aggregate.

It might be well, in this connection, to state that paving authorities, when admitting in competition any of the proprietary or patented pavements, should insist upon a full and complete specification for each of the types in question, so that when a pavement is laid the engineer will have sufficient knowledge of the materials comprising the pavement to enable him to control its construction. No pavement of any character is laid in the city of Philadelphia unless information is furnished: First, as to the quality and properties of the material to be used; second, the preparation of the mixture at the plant; and, third, the proposed method of laying the mixture on the prepared foundation.

In the preparation of the mixture all materials are subjected to rigid plant and laboratory inspection. During the actual operation, inspectors with engineering education or training are assigned to each asphalt plant, to inspect, in so far as can be done at the plant, the raw materials as to quality and mechanical grading of the sand, crushed stone and mineral filler or stone dust, and daily samples representative of the materials used and mixtures made at the

plant are sent to the central laboratory where they are tested and the results filed as a permanent record of the pavements laid.

The specifications stipulate the penetration of bitumen and temperature within limits sufficiently wide to cover all conditions, but definite instructions covering these two points and based on the amount and character of traffic are given to the inspector for each contract.

The foundation having been laid to true line and grade, the next step is to obtain a correct and uniform depth of binder and wearing surface, raked to a true cross section and grade, after which it must be thoroughly rolled; and without doubt the most important single point in the laying of bituminous wearing surfaces is the question of rolling. More pavements are failing today through displacement from their original from than from all other causes combined, and aside from the other reasons to which this result may be attributed (and there are undoubtedly many) it is certain that unless a pavement is free from waves at the time of its completion it never will be, as the tendency of the pavement is to push under traffic, which increases the wavy condition. It is important, therefore, that all pavements be thoroughly compressed, carefully rolled and cross-rolled, with properly maintained rollers operated by skilled roller engineers. It has been the practice in some cities to use only one roller, but far better results can be obtained by using a light roller for the initial compression and a heavier roller for the final compression. The best results obtained in Philadelphia have been by an equal amount of transverse and longitudinal rolling with a 2½-ton roller, followed by an equal amount of transverse, longitudinal and diagonal rolling with an 8 or 10-ton roller.

In the laying of sheet asphalt or bituminous concrete, where brick gutters are used and adjacent to block runners along car tracks, it is good practice to lay the finished surface of the pavement from ⅛ to ¼ in. higher than the brick gutters or runners. It is difficult in the rolling to secure final compression next to these blocks, and traffic will further compress that portion of the pavement, naturally causing the development of low spots which hold water and result in deterioration.

It is questionable whether, as compared with the old so-called open binder, the latest specification for the binder course which calls for a grading of stone from 1 in. diameter down, with the addition of 25 to 35 per cent. of sand, producing a mixture with greatly reduced voids, does not result

in giving a decreased mechanical bond for the wearing surface, and whether, in view of the possibility of the top shifting under traffic, it might not be advisable to use the open binder exclusively.

In the grading of the mineral aggregate, special attention must be paid to the percentage and penetration of the asphaltic cement which, of course, is dependent upon the asphalt used, climatic and temperature conditions, and the character and amount of traffic.

The following is the present practice in Philadelphia under average conditions:

Philadelphia Surface Mixtures, 1914

Traffic conditions:	Light.	Medium.	Heavy.	Patching.
Per cent. bitumen	10½	10½	10¾-11.0	10¾
Penetration:				
Mexican	60–65	50–60	45–50	50–55
California	60–65	50–60	45–50	50–55
Bermudez	60-65	50-60	45-50	50-55
Trinidad	55–60	45–55	40–45	45–50

Note—Bitumen figures varied slightly from the above to take care of unusually fine or coarse sand.

Bituminous Macadam, Penetration Method

In penetration work, after the base has been prepared, and clean, approved hard stone has been spread to the required depth, the recognized practice is to use from 1¼ to 1½ gals. per sq. yd. of bituminous material conforming to the specifications. Then, after chipping and rolling, a flush coat or seal coat is applied of from ¼ to ½ gal. per sq. yd. and another application of chips, before the final rolling.

The tendency has been to discontinue this method of construction, where it is practicable to use the mixing method. Although it is an admitted fact that the penetration method is slightly cheaper than bituminous concrete in first cost, when the life and maintenance of the respective pavements are taken into consideration it is doubtful whether the penetration method is not more costly than the mixing method.

There probably has been more deterioration in roads built by the penetration method than in any other modern type of construction. Generally speaking, this is due to too much personal equation entering into the work, as, for instance, unequal distribution of binder, resulting in the formation of waves and ruts which always grow worse under traffic. The method of heating the binder is not as easily controlled as in a mixing plant and often results in overheating, causing weak spots in the pavement. Even if the method of construction were more ideal, it is ques-

tionable whether the penetration method should be used, as at the present time there are on the market a number of portable mixing plants of all sizes that would be practicable in most sections of the country, and it is generally conceded that the mixing method is preferable to the penetration, provided first cost is not the dominating factor.

Bituminous Pavement, Mixing Method

The specifications in the city of Philadelphia are as definite and rigid in their stipulations covering the preparation and laying of bituminous concrete pavements as they are in the case of sheet asphalt. All these pavements are now being laid on a 4-in. concrete base instead of on an existing macadam foundation, which heretofore has been the generally accepted practice on country roads. In view of the increased amount and change in character of the traffic, even though slightly more expensive, it has been considered advisable to provide for a 4-in. concrete base on top of the broken stone or telford base, due to the tendency of the macadam base to shift or further consolidate under traffic and possible subgrade trouble, all of which tend to bring about a wavy or uneven surface.

In resurfacing old water bound macadam roads, where the road consists of either telford or macadam base, the broken stone surface is removed to a depth sufficient to conform to the required cross section and grade. Where the telford surface is exposed, the irregularities are broken off with a napping hammer and the depressions filled in, and upon this prepared surface is placed a 4-in. concrete base, mixed in the proportions of 1:3:6, so laid as to secure a very rough but regular surface to form a bond between the concrete base and the bituminous top. In conjunction with the concrete base a concrete header curb is constructed extending 6 ins. beyond the fixed edges of the bituminous pavement and to the finished grade. After the concrete base has developed a hard set, and from one to two days prior to the placing of the bituminous wearing surface. the base is thoroughly cleaned of loose and foreign material, by sweeping, and is then covered with an asphaltic cut-back mixture consisting of equal parts by volume* of asphaltic cement, 55 to 65 penetration, and commercial naphtha, 52 to 55 gravity; the mixture being applied by a pressure distributor at the rate of ⅛ gal. per sq. yd. The

*"Equal parts by volume" may be said to be 58 to 60 per cent. by weight of asphalt and 42 to 40 per cent. by weight of naphtha.

object of this paint coat is to secure a better bond between the concrete base and the bituminous top. The bituminous top, 2 ins. in thickness, is laid under the same requirement as to preparation, laying, rolling and inspection as for sheet asphalt. Where a new pavement is laid on the earth subgrade, a 5-in. concrete foundation is used.

One of the important features in connection with obtaining the best results in bituminous concrete construction is the use of good, hard, durable stone, free from dirt and decomposed material, in the wearing surface, as decomposed stone in the mixture will naturally develop weak spots in the pavement, ultimately resulting in failure.

The following penetrations are used in Philadelphia:

	Heavy Team or Motor Traffic.	Medium or Light Traffic.
Trinidad Asphalt	45-60 penetration	50-55 penetration
Bermudez, Mexican and California	50-55 "	55-60 "

There always has been a tendency to slight or overlook details in this class of work, and, as an illustration, the following is quoted from the fourth annual report of the Association for Standardizing Paving Specifications, 1913:

> In the case of a park driveway or a suburban highway, a bituminous concrete pavement may be successfully used without a curb; no other protection for the edge of the pavement is required except to provide a coarse, grainy surface into which the paving material is rolled.

There is no question but that this was the generally accepted practice at the time this report was made. Later experience, however, has demonstrated that this method of construction might answer for wide roads with light traffic, but where the width of the paved surface is 18 ft. or less the turning of traffic on and off the bituminous surface will result in grinding or cracking the edges and also, unless a perfect bond has been secured with the base—and this cannot be relied upon—heavy wheel loads, at a distance of 1 ft. to 2 ft. from the edge, will produce a spreading of the bituminous surface. To obviate this, provision is made in the Philadelphia country road specifications for a 6-in. concrete header curb on either side of the road where the road is not paved to the full width.

The idea that the introduction of stone into the bituminous mixture is a cure for all the troubles which have developed in recent years with sheet asphalt is wrong. Topeka and later specifications developed from it, calling for about 25 per cent. of ½-in. stone, cannot be considered ideal bituminous pavement, as the stone is not sufficient in quantity

or size to produce the interlocking required for stability in the mineral aggregate. In laying this type of pavement the segregation of the mixture in pockets of fine and coarse material will produce a pavement with irregular wearing qualities, unequal compression and unequal ability to resist displacement by traffic; with the use of stone in larger quantities a much more stable pavement is secured, but an element of danger is introduced with the use of large stone, in the mixing and laying, brought about by the segregation of the large and small sizes of stone, with the result that the pavement will not be as uniform in character as is the case with a standard sheet asphalt pavement.

Maintenance of Bituminous Pavements

We all know that the success of any pavement depends on the maintenance, and the success of maintenance depends largely on attention to details, for instance, in cutting out the old material and cleaning the base, placing the new material, rolling, etc. Judgment and experience are necessary in determining the extent of the work to be done and the amount of material to be cut out for each individual patch. A patrol maintenance system will do more to preserve roads and pavements and prevent deterioration than any one thing.

There are two methods that can be considered for the maintenance of bituminous pavements by contract: first, by the square yard; and, second, on the tonnage basis. Working on the square yard basis, there is more or less of an element of chance taken by the contractor as to the depth of binder and top to be laid, due to the age and unequal wear of the pavement, and as the binder is naturally the cheaper the contractor is apt to increase the depth of the binder and decrease the depth of the top. On the tonnage basis due to the fact that the price bid for the binder is usually about one-half that for the top, there is a tendency on the part of the contractor, unless the work is closely inspected, to cut down on the amount of binder and to increase the amount of top. Thus in the two methods the case is reversed. On the tonnage basis, however, since payment is made only for the actual amount of binder and top used, there is really no "gamble" on the part of the municipality or the contractor as to the amount of each class of material to be furnished, which is the case on the square yard basis. It is, however, more desirable for the city to own an asphalt plant as this class of work can be

handled more satisfactorily by municipal forces than by the contract system.

In order to assist in solving many of the perplexing problems arising in connection with paving work, it has been found advisable to build experimental and service test roads. If this practice had been consistently followed, the result would be that we would not have the extensive failures we have had through the use of untried materials and methods of construction, which should have been tried out experimentally on a small scale, such as was done in Maryland on Park Heights Ave., built in 1910; and the White Plains experimental road, Borough of the Bronx, New York, built in 1910. A service test roadway such as built in Philadelphia in 1912-13; and Second Ave., New York, built in 1912, which comprise more or less standard methods of construction and materials, should be of great value in compiling permanent records of the comparative value of the different types of the present-day standard pavements. Work of this kind should be encouraged as it will ultimately result in solving many of our paving problems. Detailed information relative to Park Heights Ave., White Plains Road and the service test roadway has been published in report form and distributed to the public, but, up to the present time, no information has been available with reference to the Second Ave. work. It is hoped, however, that this data will be made public in the near future.

If we are to arrive at any solution of our troubles, it behooves all of us to be frank, and, instead of coming to the various road conventions and telling of the successes, we must come to the front and tell of the failures, as it is an indisputable fact that every state or municipal officer here today has and is having his failures. This being the case, why not give the "other fellow" the benefit of your experience? If this thought were carried out there would be less failures.

PRESIDENT McLEAN: The next speaker will be Mr. D. D. Price, State Engineer of Nebraska. Is Mr. Price here? Apparently not.

The discussion of the excellent paper by Mr. Uhler will be continued by R. A. Meeker, State Engineer of New Jersey.

R. A. MEEKER (State Highway Engineer of New Jersey): Though Mr. Uhler very modestly states that he is confining his paper to such problems of bituminous work as may present

themselves in the "City of Brotherly Love," still that experience is by no means small and covers most of the conditions encountered generally.

He very wisely places at the head of the list of perplexities that of the intrusion of street railway tracks into the pavement and wisely proposes to place concrete under the ties in order to prevent the alternate depression and elevation of the rails under traffic. The movement of the rails will ruin any bituminous pavement adjoining them. Therefore, the interposition of some form of block pavement is necessary. Mr. Uhler suggests one row of blocks on either side of the rails. The speaker would add to this single row a double one at every rail joint for three reasons: First, to facilitate the work of repairing the joints; second, to prevent the disturbance of the bituminous pavement during such repair, and third, to discourage the practice of driving along the rail, thus forming a rut that is very hard to remove. All of these things are very destructive and shorten the life of bituminous pavements, and the small added first cost will more than repay the outlay during the first year of the life of the pavement.

Mr. Uhler describes briefly country road bituminous pavements. The specifications for these with the exception of Amiesite are very similar to those adopted by New Jersey. We are just as particular in specifying the sizes of stone used in Amiesite as we are for Warrenite and Filbertine. He gives the proportion of stone or mineral aggregate as 92 per cent. without any reference to size. We specify that the cold mixed asphalt concrete shall contain a mineral aggregate graded as follows:

For the bottom course:

Stone passing a 2-in. opening and retained on a 1-in. opening, 70-80%.

Stone passing a ½-in. opening and retained on a ¼-in. opening, 3-5%.

Stone passing a ¼-in. opening and retained on a 10-mesh screen, 5-9%.

Stone passing a 10-mesh screen and retained on a 30-mesh screen, 5-9%.

Stone passing a 30-mesh screen and retained on an 80-mesh screen, 3-6%.

Stone passing an 80-mesh screen and retained on a 200-mesh screen, 3-7%.

Stone passing a 200-mesh screen, 2-6%.

For the top course:

Stone passing a 1-in. opening and retained on a ½-in. opening, 7-5%.

Stone passing a ½-in. opening and retained on a ¼-in opening, 63-70%.

Stone passing a ¼-in. opening and retained on a 10-mesh screen, 5-9%.

Stone passing a 10-mesh screen and retained on a 30-mesh screen, 6-10%.

Stone passing a 30-mesh screen and retained on an 80-mesh screen, 3-6%.

Stone passing an 80-mesh screen and retained on a 200-mesh screen, 3-7%.

Stone passing a 200-mesh screen, 4-8%.

The speaker is thus particular in describing the sizes and proportions of the stone because he feels that upon this factor depends largely the value of the pavement, and improperly sized or graded mineral aggregate will spoil the best bituminous concrete.

Our experience differs from that of Mr. Uhler in the amount of bitumen used; he gives the percentage as from 8 to 11 of the mass. Our limits are between 6 and 8 per cent. When the quantity exceeds 8 per cent. we are troubled with waves and ridges in the pavement, also with more or less bleeding. On the other hand, if the percentage falls below 6, the pavement is apt to check or crack.

The speaker entirely agrees with Mr. Uhler in his statement that rolling is a very important factor in the laying of bituminous pavements. Proper rolling cannot be too strongly urged. It should receive the closest attention of the engineer at all times because, as he truly remarks: "It is certain that unless a pavement is free from waves at the time of its completion, it never will be."

Quoting once more from Mr. Uhler:

"The idea that the introduction of stone into the bituminous mixture is a cure for all the troubles which have developed in recent years with sheet asphalt is wrong. Topeka and later specifications developed from it, calling for about 25 per cent. of ½-in. stone cannot be considered ideal bituminous pavements, as the stone is not sufficient in quantity or size to produce the interlocking required for stability in the mineral aggregate. In laying this type of pavement, the segregation of the mixture in pockets of fine and coarse material will produce a pavement with irregular wearing qualities, unequal compression and unequal ability to resist displacement by traffic; with the use of stone in larger quantities, a much more stable pavement is secured, but an element of danger is introduced with the use of large stone, in the mixing and laying, brought about by the segregation of the large and small sizes of stone, with the result that the pavement will not be as uniform in character as is the case with a standard sheet asphalt pavement."

In other words, a bituminous pavement is good if properly prepared and carefully laid.

PRESIDENT McLEAN: Mr. E. A. Kanst, Superintendent of the Lincoln Park Board of Commissioners, who was to have followed, is unable to be here, but he has deputed his chief engineer, Mr. George T. Donoghue to take up the discussion.

E. A. KANST (Superintendent of Lincoln Park, Chicago, Ill.);* The choice of blocks to be used adjacent to street-car rails, in my opinion, should be between granite blocks and creosoted blocks, the former being given preference on ordinary streets and the latter on boulevards. However, small granite blocks neatly dressed are now competing with creosoted blocks even on boulevards and boulevard crossings.

Mr. Uhler in his paper says that in Philadelphia the bituminous specifications for country road work are drawn so that the pavements compete with each other, and that the work is awarded to the lowest bidder irrespective of the type bid on. I believe we would be interested in knowing how this plan has worked out. With whom does the decision rest as to which pavements may compete with each other? Do the specifications cover by trade name the pavements that are eligible to the competition?

The question of rolling bituminous pavements is a ripe one for discussion. In the case of a bituminous surface laid on a concrete base the ultimate success of the road is in a large measure in the roller-man's hands. And where the foundation is macadam the roller-man's responsibility is doubled. A contractor that has good roller-men should look upon them as valuable assets.

In rolling bituminous pavements close to curbs the tendency seems to be to stay too far away from the curbs, relying almost entirely upon hand tamping for compression near the curb. In the Lincoln Park system we are doing away with as much hand tamping as possible and trying to get compression close to the curb with the steam roller. Our curbs, of course, are scratched or occasionally marred, but on the whole I believe we are getting better results both in appearance and stability.

We have practically abandoned the penetration method of construction in Lincoln Park for all classes of work save patching. Lack of uniformity in results in our penetration work is one of the principal reasons for the giving up of this type of construction. The class of labor doing this work requires constant supervision. The quantity of bitumen used per square yard will vary from 50 to 75 per cent within the same day. Just as many roads have failed that were built by the penetration method on account of having an excess of bitumen as have failed for having a deficiency.

Mr. Uhler has told us of the laying of a 4-in. concrete base on top of the broken stone or telford base—results seem to

*Read by Geo. T. Donoghue, Chief Engineer of the Board of Lincoln Park Commissioners.

have been satisfactory. The question of whether it would not have been just as satisfactory and probably more economical to have laid the bituminous wearing surface directly on the old macadam base appears to me to be worthy of discussion. A well laid macadam road that has been subjected to traffic for years usually makes an excellent base for a bituminous wearing surface. Furthermore, the weak spots that usually show can be taken care of. From the economy standpoint it would seem that the money saved by the omission of the concrete base might be applied to the future maintenance of the road. I am not opposed to concrete bases for roads of this character, but I do not look upon them as a cure-all for all ruts or waves.

Relative to the use of curbs on park driveways, our engineers are usually at loggerheads with our landscape men. The lanscape men contend that the driveways do not need and should not have curbs. Personally, I can see no objection to an inconspicuous curb even in park work. Without a curb the dividing line between the parkway and the driveway is usually left to the imagination, and where any attempt is made to define the boundary line definitely by keeping the sod cut, the cost of doing this work would pay for several curbs. On one of our narrow park drives built without a curb we have had the identical trouble that Mr. Uhler speaks of: viz., crowding of the bituminous surface to the edge of the pavement.

I am in hearty accord with Mr. Uhler on maintenance. Any board or governing body that is responsible for the maintenance of bituminous roads should adopt the patrol system. I know of no other pavement save water bound macadam to which the "stitch in time" proverb is more applicable.

PRESIDENT McLEAN: The next speaker, Mr. Philip Henry, consulting engineer of New York, is unable to be here but has sent a paper. At this hour I believe that it would be desirable to accept the paper without the formality of reading it. I will, therefore, ask Mr. R. Keith Compton, Chairman of the Paving Commission of Baltimore, to address you on this subject.

R. KEITH COMPTON (Chairman, Paving Commission, Baltimore, Md.): The speaker has carefully and with interest read the paper by Mr. Uhler on "Bituminous Construction and Maintenance—Recent Practice." Mr. Uhler has so thoroughly, intelligently and practically covered the ground that there is scarcely anything in his paper with which I can

disagree. It may be well to cover the high points in his paper and consider more in detail the questions which he has raised.

One of the subjects emphasized by Mr. Uhler is the placing of concrete under the ties of street railway tracks, because probably most of our troubles with bituminous pavements are on railway track streets and due in most instances to insecure foundations under the tracks.

In the City of Baltimore, where 125 miles of improved pavement have been laid in the past three years, we have found it necessary and desirable to deviate somewhat from the former method of street railway track construction and require the railway companies to install concrete under and around the ties, the former method having been to use crushed stone or ballast foundation only, and then only when forced to do so by ordinance.

When the speaker first took up the subject of more substantial track construction in this city, the first claim of the street railway companies was that the cars would have to be taken from the streets and entirely re-routed, and that this not only entailed a hardship and unnecessary expense upon the railway companies, but inconvenienced the public, and that such re-routing was not practicable in Baltimore, where the down-town streets are narrow and congested. Every railway track street which has been paved within the last three years has been paved, maintaining the cars in operation during the construction. We therefore took up the question of meeting this contention of the railway companies and outlining some plan whereby concrete could be installed under the ties and at the same time maintain car service on the streets.

The placing of concrete as a foundation for the street railway tracks in the City of Baltimore has proven a very satisfactory solution of our troubles, and we have succeeded in so placing it and maintaining car service. Our method is as follows:

Concrete foundation was placed under the tracks on several of the busiest and heaviest traffic streets in Baltimore. This was accomplished without interruption to the railway traffic. The tracks were ballasted with broken stone of size varying from 1½ to 2½ ins. After the track had been thoroughly tamped and surfaced, this stone was then penetrated with a cement grout in the proportions of 1:2, using bank sand. If any slight movement developed in the track during this operation (sometimes caused by the moisture of the grout softening the subgrade), tampers were immediately sent back

to tighten the ties by tamping in the wet concrete. It was found necessary, in placing the stone for this construction, to allow the stone between ties to remain about 2 ins. above the bottom of the tie, this insuring the grout flushing up full under the bottom of the tie. During the progress of this work test holes are cut at the top and bottom of the grades in each and every block, and the penetration of the grout examined, and in all cases it has been found that the grout has penetrated the entire 6 ins. of stone placed under the ties where the above size stone was used.

Three months after the completion of the first track treated in this manner this department had occasion to tear out one small piece of track. The concrete found under the ties was excellent, being in every respect equal to mixed concrete, all voids being found filled and the concrete dense.

The first piece of track, about 80 ft. long, treated in this manner, was experimental work, and the stone used was from 1½ ins. down to about ½ in. in size. This experiment was somewhat of a failure, because the stone was too small to allow the proper penetration of the grout.

The extra cost of this work over the ordinary stone ballast used by the railway companies, as closely as can be ascertained by the department, is a matter of 52 cts. per lin. ft. of single track, or $1.04 per lin. ft. of double track.

The railway company does all of this work with its own forces, using a No. 9 Coltrin grout mixer, and by the manipulation of a jointed chute leading from this mixer they are able to keep the mixer going continuously, even when cars are passing the point of operation, one joint of the chute leaning just to the near rail, which can be swung around when the car is passing, allowing the grout to flow on the ballast at the ends of the ties at the outside of the rail. After the car has passed, this chute is swung back towards the center of the track and the second joint of the chute, which is merely dropped in the track while the car is passing, is then placed again in position and carries the grout over to the opposite rail. In this way no time is lost by the grouting gang, and car traffic is interfered with to a limited extent only.

One of the main points to be looked after in this construction is that large stone be used as ballast, for if too small stone were allowed, the penetration of the grout would be seriously interfered with.

The amount of concrete per running foot of double track is roughly .460 cu. yd.

One would naturally suppose that the passing of cars over the track while this work is being done would interfere with

the setting of the cement, but by thoroughly tamping the stone ballast as outlined above the ballast is made to carry the weight of the passing cars.

I can only emphasize the importance in the construction of bituminous pavements of strict plant, laboratory and street inspection. In this connection I will outline to you our methods in the City of Baltimore.

At each asphalt plant is stationed an inspector, who is equipped with screens, balances, a penetration machine and thermometers to be used in testing the stone, sand, asphalt cements and temperatures of the finished mixtures. All the incoming raw materials are tested by the inspector at the plant, as received, except the asphalt and residuums, which are sampled and sent to the laboratory for analysis before they are used. Samples of the stone, sand and dust are also taken to the laboratory and tested. The inspector is given a mixture showing the percentages of stone, sand and asphalt cement by which to turn out the binder mixture, also the penetration at which the binder cement is to be maintained, each kettle being tested before it is used. The procedure for topping mixtures is as follows:

After the sand has been tested he is given a formula telling the mesh composition of the sand, the amount of sand, limestone dust and asphalt cement to be used, also the penetration of the asphalt cement. These instructions are received from the chief asphalt inspector. Each plant is visited at least once a day by the chief asphalt inspector, who makes an inspection of the plant and materials being used and collects samples of the asphalt cements, finished mixtures and the inspector's reports. These samples are taken to the laboratory, the asphalt cements being checked and the mixtures analyzed and any irregularities noted and the plant inspector immediately notified of same. The chief asphalt inspector during the day visits each street on which any material is being laid and takes samples, which are tested, and if found deviating from the mixture set, the inspector is at once notified of it and the trouble remedied.

When the mixtures arrive on the work they are tested for temperature by the street inspector, who oversees the laying of the binder and surface mixtures, seeing that the surface gets the proper amount of rolling and that the binder and wearing course are of the required thickness. The street inspector at the finish of each day's work sends a post-card to the laboratory showing the number of loads and batches of material received on the work, and also the yardage of material laid. These figures are checked against the reports

of the plant inspector, the yardage per batch obtained and a report of same made to the principal assistant engineer and any irregularities noted and corrected. In this manner we can tell whether or not the binder and topping laid on the previous day are of the required thickness, and this is an excellent check on the street inspector.

I can only emphasize Mr. Uhler's point of thorough compression, and this can only be obtained by thorough rolling. After carefully considering the matter the City of Baltimore has this clause in its specifications relating to this phase of the construction:

> After raking, the surface mixture shall at once be compressed by rolling with a steam roller weighing not less than 150 pounds to the inch width of tread, after which a small amount of cement shall be swept over it with a soft bristle broom. Then it shall be thoroughly compressed by a second roller weighing not less than 250 pounds to the inch width of tread, the rolling with the heavier roller to be continued until the compression and surface are satisfactory to the engineer.

This seems to thoroughly cover the situation if the conditions are faithfully complied with.

The question of liners is a very important one, and I believe that the City of Baltimore has used every conceivable liner on the market—vitrified block, wood block, scoria block and selected granite block. Scoria block has not been in service long enough for us to make up our mind as to just what it will be, although to the writer's knowledge it has been used with very good satisfaction in the City of Washington.

For the sake of appearance and service, on light traffic residential streets wood block, say 4½ ins. in depth, with light treatment, set on a firm mortar bed, will give good service, but in this connection the construction of the street railway tracks must be most substantial. Any amount of vibration in the rails will let in water, and your wood block will soon begin to deteriorate and the asphalt pavement adjacent to the wood block will deteriorate from the under side. The blocks should not be heavily treated, because the surplus oils from the block will be taken up by the asphalt and the asphalt will soften and curl up adjacent to the wood liners.

On heavy traffic streets we are now using well selected granite block set on a firm mortar bed. The specifications for this are as follows:

> When specified, selected granite blocks of uniform size will be used as liners along rails adjacent to sheet asphalt paving; the liners will conform to the specifications for granite blocks, except that they shall be not less than 8 inches nor more than 9 inches long; not less than 3½ inches nor more than 4 inches wide; not less than 4¾ inches nor more than 5¼ inches deep; and dressed so as to form when laid close, joints not exceeding one-quarter of an inch in width, and poured with a filler as specified.

I think conditions are better met by using a bituminous filler in granite block liners rather than a cement filler, for the reason that if a cement filler is used the adjacent sheet asphalt paving cannot be laid as promptly as can be done if the former filler is used, and in rolling binder and topping the cement filler is likely to rupture.

Mr. Uhler recommends that it is good practice to lay the finished surface of the bituminous pavement ⅛ or ¼ in. higher than the brick gutters or liners. We have gone so far as to lay it uniformly ½ in. higher, and find that by this method we are obtaining good results.

A bituminous pavement should never be laid in railway areas. Granite block new or re-cut on heavy traffic streets and vitrified block on medium and light traffic on railway streets should be regarded as standard and safe construction in connection with bituminous pavement.

On the question of binder, we find that a medium one probably gives the best results. It should be composed of stone, all passing a 1-in. screen, 85 per cent. of which to pass this screen in its longest dimension, and of the remaining 15 per cent. no piece shall have a larger dimension than 1¼ ins. After passing the heating drums it shall contain not less than 15, nor more than 35 per cent. passing a 10-mesh screen. This gives an abundance of variation, and if the stone does not contain the proper amount of material passing a ½-in. screen the deficiency can be made up by the addition of gravel or sand. With an extreme open binder on a heavy traffic street I would fear the topping would be pushed down into the voids of the binder, the final result being that the binder stone will work up through the topping.

In the City of Baltimore some ten miles of bituminous concrete, Topeka specifications, have been laid, with varying degrees of success. There has been quite a tendency in some instances, particularly with heavy slow-moving vehicles, for the 2-in. topping to push. This has occurred whether the top of the concrete was purposely left smooth or rough. We have had analyses made of the material in such instances, as well as analyses of the material and mesh composition where such pavements have been laid with apparent success. Practically, we can find no difference between them. On all examinations, whether the topping showed a disposition to push or whether it remained in place, we have found the presence of dampness on the top of the concrete, causing the underside of the bituminous topping to disintegrate. To my mind this proves conclusively that a binder or paint coat under all bituminous pavements is absolutely necessary, and

that the old-fashioned notion that the binder was constructed not only to cheapen the pavement and to serve as a cushion for the topping but to act as an air space to protect the topping from the dampness is correct, and it is for this reason that bituminous concrete pavements laid on a rolled stone base rather than a concrete base have apparently been more successful, although the speaker does not indorse this as standard construction. In other words the rolled stone base acts as an underdrain for the topping, keeping the underside of the wearing surface dry.

As to the maintenance question, I am fully convinced that this question can only be satisfactorily solved by every municipality, provided it has a sufficient area of bituminous pavements, owning a municipal plant. We all know that as soon as a small hole develops in a bituminous pavement it should be repaired, because the longer it remains the larger it becomes. Prompt measures are therefore necessary. No contractor wants to shift his gang and equipment to the far end of a city to make repairs unless he is aware that the amount of repairs from that end of the city justifies such removal.

With a municipally owned plant, while it is possible that repairs may be a little more costly, it is certainly quite evident to my mind that a municipality can maintain its bituminous streets in better shape than by contract.

PHILIP W. HENRY (Consulting Engineer, New York, N. Y.):* When the Secretary of your Association asked me to take part in the discussion of Mr. Uhler's paper, I told him that, as I had not been in direct touch with "recent practice of bituminous construction and maintenance," I did not know that I would have anything to offer, but that if he would send me a copy of Mr. Uhler's paper I would be glad to look it over and see if I could add anything of value.

In reading the paper it became evident that certain conclusions which Mr. Uhler has set forth, based upon his recent experience in bituminous construction, including sheet asphalt, are much the same as those which were drawn fifteen or twenty years ago by those who were then engaged in laying sheet asphalt. For instance, Mr. Uhler calls attention to the fact that in Philadelphia a different penetration of bituminous cement is used in surface mixtures, depending upon whether the traffic is light, medium or heavy, or whether used for patching. From 1889 to 1892, as superintendent of the

*Written discussion submitted but not read at the convention.

Barber Asphalt Paving Co. at Omaha, Neb., my attention was called to the behavior of different asphalt mixtures under different degrees of traffic. Those under heavy traffic with asphalt cement of high penetration were inclined to roll, while on streets of light traffic, mixtures of lower penetration were inclined to crack. Therefore, with the approval of the chemist of the company, who at that time was Prof. H. C. Bowen of the Columbia School of Mines, I adopted different penetrations in accordance with traffic. My recollection is that these penetrations were 55 on the Bowen penetration machine for heavy traffic, 70 for medium traffic and 85 for light traffic, the bituminous cement being made from Trinidad refined asphalt, which at that time was the only bituminous paving cement (except coal tar) in the market. On the Dow machine these penetrations would be about 20 points lower, and they correspond quite closely with the penetrations adopted in Philadelphia.

I am in hearty agreement with Mr. Uhler's criticism of the penetration method on roadways carrying any considerable amount of traffic. The mixing method is much more certain in guaranteeing definite proportions of mineral aggregate and bituminous cement and a uniform mixture. There is comparatively little difference in the cost of the two methods now that portable mixing plants have been evolved. The amount of bituminous cement per square yard is practically the same. In Mr. Uhler's paper he states that in the penetration method there are from 1½ to 2 gals. of bituminous cement used per sq. yd., which at 8¾ lbs. per gal., are equivalent to 13⅛ to 17½ lbs. per sq. yd. By the mixing method a bituminous surface 2 ins. thick, weighing 200 lbs. per sq. yd., will contain from 7 to 10 per cent. of bituminous cement, depending upon the size of the mineral aggregate, the latter percentage pertaining to ordinary sheet asphalt. Therefore, by the mixing method 2 ins. of bituminous surface will contain from 14 to 20 lbs. of bituminous cement per sq. yd., which is practically the same as is used in the penetration method, where it is practically impossible to obtain uniform results. I am therefore of the opinion that the penetration method should be used only on roadways of very light traffic.

I also notice that in Philadelphia, bituminous surfaces, whether concrete or sheet asphalt, are laid upon Portland cement foundations, 4 ins. being used on a subgrade of old macadam and 5 ins on a subgrade of earth. This is a step in the right direction and is in line with the opinion which I formed some years ago. In a paper on "The Future Road" which I presented to the First International Road Congress held in

Paris in October, 1908, and which I attended as delegate representing the State of New York, I stated:

> From the present outlook it is only a question of time, when Portland cement concrete will form the foundation of important country roads, as it now forms the foundation of city pavements. In building new roads future traffic should be taken into account, and a foundation sufficient for all reasonable development should be provided. As this determination is dependent upon local conditions, it is sufficient for the purpose of this discussion to call attention to the importance of an unyielding foundation and to the consideration of Portland cement concrete on all important roadways.

It would seem, however, that Philadelphia is carrying this principle too far in requiring a 4-in. Portland cement concrete base on top of existing macadam or telford. Where, in cutting down the surface of the old macadam in order to provide room for the bituminous wearing surface, there remains a minimum of 5 ins. of macadam or telford which has been thoroughly consolidated by traffic, I would consider that foundation ample for all ordinary traffic. In 1886, if memory serves me, the macadam roadway on Ashland Avenue, Chicago, was resurfaced with 1 in. of open binder and 2 ins. of sheet asphalt and rendered excellent service for a number of years. Similarly, the macadam roadway on Broadway, New York City, from 59th St. to 106th St., was resurfaced with excellent results about the year 1890. Work of this nature gave satisfactory results in other cities, and seems the best method of resurfacing a macadam roadway. Generally speaking, therefore, I would advocate putting 2½ to 3 ins. of bituminous surface on an old macadam, brought to subgrade by cutting down the projections and filling depressions with broken stone, provided that there remain at least 5 ins. of well compacted macadam or telford as a foundation.

I was also much interested in that part of Mr. Uhler's paper where he speaks of using "an asphaltic cut-back mixture," consisting of about equal parts of asphaltic cement and naphtha, to be applied to the concrete base in order to secure a better bond with the bituminous surface. This method was used in New York City, more particularly on Eighth Ave., about 1895, in order to overcome the shoving or rolling of the asphalt mixture on a certain block of that avenue where the concrete foundation had a very smooth surface. It was found, however, that an asphalt cement having a penetration around 20 would serve the purpose better than the ordinary paving cement of 55 to 65 as noted by Mr. Uhler. I would therefore recommend that, in using this "cut-back mixture," a much lower penetration be used than the ordinary bituminous paving cement.

Another conclusion of Mr. Uhler in which I am in hearty sympathy is the following:

The idea, that the introduction of stone into the bituminous mixture is a cure for all the troubles which have developed in recent years with sheet asphalt, is wrong. * * * An element of danger is introduced with the use of large stone in the mixing and laying, brought about by the segregation of the large and small sizes of stone, with the result that the pavement will not be as uniform in character as is the case with a standard sheet asphalt.

In my paper of 1908 already referred to I called attention to the same difficulties, as follows:

While the use of large particles lessens the cost of pavement in the amount of bituminous cement used, it must be remembered that broken stone is generally much more expensive than sand, and that in many sections, particularly in the central part of the United States, it is difficult to find a stone hard enough to resist wear and crushing. No matter how well the large particle may be imbedded, it is liable to be crushed or cracked by the sudden blow of traffic, thus forming a weak spot in the wearing surface. In practice, too, it has been found difficult to get a uniform mixture of large and small particles. While the mixture may be theoretically perfect in the mixer, the smaller particles come to the surface of the wagon during the haul to the road; so that as actually laid the bituminous concrete may present a surface of varying density, some portions being so coarse and porous as to absorb water. It is therefore probable that sand, generally available at reasonable prices in most localities, will prove the best material for the wearing surface of all important roads, as it has proven the best material for the wearing surface of the city asphalt pavement. This, however, is largely a local matter, and it may be that stone screenings, largest size half an inch in diameter, mixed with sand, will prove the most economical, all conditions being duly considered. But whether broken stone, screenings or sand be used, it is important that the mineral particles be so graded as to reduce the voids to a minimum. It is especially important that on roads of considerable traffic, from 6 to 10 per cent. of the wearing surface should consist of particles which will pass a sieve 200 meshes to the lineal inch, or, in other words, as fine as Portland cement. As such fine particles are seldom found to this extent in sand, it is customary to add ground limestone or Portland cement to the mixture.

I am also in accord with Mr. Uhler in his doubt as to whether, as compared with the old so-called open binder, the close binder, made with the addition of 25 to 35 per cent. of sand, may not increase the danger of the top "shifting under traffic," or shoving, as it is generally called. The open binder was introduced specifically to lessen the danger of shoving, and was fairly successful in bringing about this result. The close binder is so like the ordinary paving mixture, which, on account of its denseness, is prone to shove on a smooth base, that it is a question whether it is worth the cost of sand and additional bitumen as compared with the open

binder. This, however, is a matter of experience rather than of theory, and it would be interesting and instructive to have the views of those who have had experience with both kinds of binder under similar conditions.

While not pertinent to Mr. Uhler's paper, I would like to call to the attention of the Association that, though in nearly every industry there have been great advances in the recovery of waste products, there has been no advance in this direction, as far as I am aware, in bituminous pavements. I refer specifically to the recovery and re-use of the bituminous surface mixture. In 1887 when I first became connected with this industry as street foreman for the Barber Asphalt Paving Co. in Buffalo, I found that the old asphalt mixture, after being taken from the street, was reheated in pans by hand, with perhaps a slight addition of a soft asphalt cement, and then used in repairing pavements. There was also put in operation about that time an elaborate plant for reheating the old pavement on a large scale, by putting it through drums and by forcing hot air into the receptacles containing the old pavement which was first broken up into small pieces. Though this plant must have cost $30,000 to $40,000 it was abandoned after a few years' trial on account of the difficulty in producing a uniform mixture and the great danger of burning the material. In order to get over this latter difficulty, experiments were made in New York by heating the old pavement in tanks containing steam coils, somewhat after the method used in refining Trinidad and Bermudez asphalts. It was found, however, that as bituminous concrete is a very poor conductor of heat, this method of treatment was not economical. Experiments were then made, more particularly in Philadelphia, in grinding up the old asphalt pavement as the European rock asphalt is ground, and then mixing a small proportion of it with batch of new mixture, thus doing away with the necessity of heating the old mixture separately. This method was fairly successful, but was finally abandoned for various reasons. Owing to the great reduction in the price of bituminous cement, brought about by the development of the California and Mexican oil-asphalts, the advantage in re-using the old mixture is not so great as it was twenty years ago, but even so, it would seem that the mineral aggregate and the bitumen which make up the bituminous pavements are well worth saving. While mechanically it is possible to recover the mineral aggregate and the bitumen separately, so that they can both again be made to comply with any specifications, it has not been demonstrated on a large scale that such recovery can be made on a basis that will compete with

new aggregate and new bitumen. That this will be brought about, however, is quite among the possibilities, as in somewhat similar lines great advances have been made the past ten years.

PRESIDENT McLEAN: Time is passing and we have on the program a paper on concrete roads. I believe that the discussion on the subject of bituminous construction and maintenance may be postponed until the end of the afternoon, when we can return to it, if time permits. In order that no injustice may be done to those who have prepared papers, I will therefore continue with concrete roads, and in the absence of Mr. Kuelling we will ask Mr. Hirst to read the paper, "Concrete Roads," prepared by Mr. H. J. Kuelling, County Highway Commissioner of Milwaukee County, Wisconsin.

A. R. HIRST (State Highway Engineer of Wisconsin): Mr. Kuelling is the County Highway Commissioner of Milwaukee, the Cook County of Wisconsin, where there has been constructed in the last three years about fifty miles of concrete highway. I believe that Milwaukee County now stands second in the United States in the mileage of concrete roads.

Mr. Uhler mentioned the fact that we should mention our failures. As a matter of fact, we built in Milwaukee County six miles of concrete the first year, a portion of which was almost a complete failure, due to the fact that we used dirty gravel. Mr. Kuelling unfortunately has recently had appendicitis and is unable to read the paper which, however, he did prepare.

Concrete Roads

By H. J. KUELLING
County Highway Commissioner of Milwaukee County, Wisconsin

The subject that has been assigned to me is "Concrete Roads" and I will therefore limit my remarks to the subject in question and not refer to the subject of "Concrete Pavements," which, I believe, has some quite different problems.

While there are several isolated cases of concrete roads that are fairly old, the pavement is a type that is quite recent and has had a phenomenal growth within the last five years. Naturally, with such a growth there have come about changes in the opinions of engineers relative to the best practices.

Without a doubt, there will be many great changes before the standards are unified and many of the things we are now doing will be looked back upon as rather poor engineering.

Because of these rapidly changing conditions, the remarks I am about to make will be points of serious discussion and many of my opinions will, no doubt, be disproven within the course of a few years if they are not disproven almost immediately.

Roadbed.—As in all forms of road construction, the roadbed for a concrete road is almost as important as the wearing surface itself. However, because of the rigid nature of the pavement, I believe that the roadbed can be of poorer quality for this form of road construction than that in any other form that I know of. This does not mean that I recommend the neglecting of proper preparation of the roadbed; but as engineers know, in preparing a road in very dry weather, springy or spongy places are sometimes overlooked and in the cases of non-rigid roads these places will show up at some future date, whereas with a concrete road I believe that the slab often bridges these places and no serious results come except a possible cracking of the road. I think a little too much attention has, perhaps, been paid to thorough rolling of the subgrade rather than to the thorough destruction of the old road surface in order to have a subgrade of uniform density under the new road. In our own work, we did practically no rolling other than that accomplished by traction engines drawing the graders; or, in a few cases, by tractors hauling material.

Width and Thickness.—This is a subject that has given rise to a great deal of discussion. Our practice is to use a flat subgrade with fairly deep ditches alongside the road to care for drainage. Our experience has been that where there is a motor traffic of a thousand or more vehicles every day, an 18-ft. road is none too wide. With only a few hundred vehicles per day a 16-ft. or possibly a 15-ft. road might be ample. In connection with the width we must consider the ever increasing amount of reckless driving occurring upon our highways.

The thickness that we are using on our roads, which are 16 and 18 ft. in width, is 6 ins. at the edges and 8 ins. in the center. I believe the thickness will be ultimately partly determined by the density and homogeneity that we are able to obtain in our concrete. I believe this because a truly homogeneous concrete will have an even wear similar to good sandstone and increased thickness will merely mean an increased life of the road.

Cement.—The getting of the proper amount of cement into the road is, I believe, one of the difficult things to accomplish at the present time, especially where the contractor is inclined to be negligent. This is largely overcome in Milwaukee County by furnishing all cement delivered to the contractor on the job. In this way there is no tendency to slight the proper amount. On the other hand, we hold him responsible within a certain degree for an over-run of cement and also make him responsible for the care of all empty sacks.

I believe that all cement for road purposes should be given thorough testing by reliable engineers. My opinion in this matter has been proven by the fact that we were compelled to reject a considerable number of cars of cement during the past season.

Coarse Aggregate.—In a few words, the better the quality of the aggregate, the better the quality and the longer the life of the road, as in all forms of road construction it is a question of cost versus economy, the high priced aggregate being sometimes more economical than the low priced local material. We prefer a stone graded from ¼ in. to about 1½ ins. and of course demand that it be clean and free from any slate, shale or disintegrated stone. In our state we limit the coarse aggregate to material having a French coefficient of wear of ten or over.

Fine Aggregate.—Wisconsin specifications for fine aggregate read as follows:

> Fine aggregate shall consist of clean, sharp grains of silica or hard silica rocks, and shall not contain over three per cent. of clay or loam. The fine aggregate shall have a reasonably uniform graduation from a size which will pass through a one-quarter inch screen down. Sand, containing an appreciable per cent of flat flakes shall not be used. Fine aggregate other than the above may be used only upon the approval of the engineer.

Pit Run Gravel.—In no case should the use of pit run material in a concrete road be permitted.

Proportions.—I believe that too often the proportions are specified more or less blindly. I believe that they should depend absolutely upon the quality of the material that is obtainable. This necessitates a careful study of the voids and the make-up of the gravel or stone that might be used. I believe that the uniformity of mixing is almost as important as the amount of cement demanded. I believe that the proportions should be those that will give the greatest density and most homogeneous concrete that can be obtained with the sand and stone obtainable. If the addition of hydrated lime or some other inactive material will tend

to assist in obtaining these results without lowering the abrasive value of the concrete, I believe it should be included in the porportions. I believe there is a wide field open for careful experiments along this line. Personally, I hope to make some abrasive tests in the near future on different mixes containing hydrated lime. At the present time Wisconsin is using a mix of 1:2:3½, but I would not for a moment say this is the proper mix for all parts of the country and with all aggregates.

Reinforcement.—I believe it is in only exceptional cases that reinforcement is necessary in a country road, these cases being only when springy spots are encountered or possibly where sufficient drainage is impossible due to the swampy nature of the territory.

Mixing.—The proper amount of mixing is another point that is open for discussion and the point I think is most commonly overlooked is the nature of the machinery. I believe that five turns with some mixers are as good as ten with some other mixers. The amount of mixing should also depend upon the shape of the individual pieces in the aggregate and also to a certain extent upon the gradation. In determining the number of turns a mixer should be given, careful attention should be paid to the speed of the drum.

Placing.—For road work proper, I prefer a spout to a boom. The main reason for this is that the material is deposited in smaller quantities, with, therefore, less tendency toward separation of the aggregate and mortar. Very commonly the boom bucket leaks and unless careful watch is maintained there is a pile of mortar left at each moving of the machine. Further, the boom is additional weight to be carried around and is often the cause of delaying the work.

Finishing.—If the concrete is maintained at proper consistency, which is such that it will flow fairly easily into place and not run like water, very little finishing is required. One man can easily keep up with a good sized crew and about all that he should do is to smooth out the markings of the strike-off board and remove any foreign matter such as sticks, coal or clay, which will always float to the surface. The finisher should use a wooden float at least 18 ins. in length and keep a sufficient distance back of the mixer so that the concrete is about ready for its initial set.

Curing.—The first step in curing is to sprinkle the subgrade in dry weather. We find this is best accomplished by the fireman connecting a small hose to the injector. The next step in curing is to protect your road with canvas in case the temperature is over 90° or in case the weather is exceedingly

dry and windy. When sufficiently hard, the concrete should be sprinkled and covered with about 2 ins. of earth from the side of the road and then kept wet (and not merely in a moist condition) for about ten days.

Joints.—The question of joints is, I believe, the most unsettled one in connection with concrete roads. We have increased our joint spacings from 25 to 35 ft. and from 35 to 50 ft. and at the present time I see no reason for shortening the spacing. I doubt very seriously the necessity for steel protecting plates, for no matter how carefully they are placed there is a tendency to chip, thus demanding an almost immediate tarring of the joints. I believe the joints of the future will be merely felt or paper with a slight rounding of the joint, with an edging tool, which will be filled in by the pounding down of the felt which has been permitted to stick up above the surface. I believe that the ability to get concrete that is homogeneous and impervious to water will have a marked effect upon the spacing of joints, as water content is more the cause of the movement in concrete than the changes in temperature.

Shoulders.—After trying both gravel and earth shoulders we have practically come to the conclusion that for double track roads, earth shoulders are preferable. We have found that it is not necessary to bevel off the edges of the concrete in order to make the shoulders stay in place and now merely round the edges to about a 1-in. radius.

Inspection.—This article would not be complete without a word regarding inspection, for if there is a type of road that demands thorough inspection it is a concrete road, as mistakes cannot be remedied the day following. The inspector should be a man of judgment who appreciates to the utmost the importance of detailed work. He should be a man of considerable "backbone" and one who has no political connection with the work.

Conclusion.—While concrete in its present form has some disadvantages, I believe that it meets modern traffic conditions as economically as any form of pavement known. I also believe that the next few years will bring about a quality of concrete and form of construction that will produce a country road having a very long life as road surfaces go, especially if traffic conditions continue to change in the direction they are now going; that is, if motor traffic continues to increase while horse-drawn traffic decreases.

PRESIDENT McLEAN: The next speaker will be our

authority on concrete highways, the State Highway Commissioner of Michigan, Mr. Frank F. Rogers. (Applause.)

FRANK F. ROGERS (State Highway Commissioner of Michigan): Mr. President and Gentlemen: I wish to say that this very excellent paper by Mr. Kuelling on concrete roads did not reach me until I was about to leave for this convention, and as I had already prepared a few words along lines that I have been investigating I will not take much time in referring to his paper. I might say, however, that with the exception of the mix referred to, viz., 1:2:3½, which has been adopted in the Michigan state highway specifications, the general specifications given in Mr. Kuelling's paper are almost identical with those followed by Wayne County. The mix used in Wayne County is 1:1½:3. Most of the Wayne County concrete roads are 16 ft. wide, laid with a sub-base, and are 16 ins. thick at the edges and 8 ins. thick at the center, the crown being made by the added thickness of the concrete. The aggregates used in Wayne County are plain washed gravel and washed sand.

I have referred mostly to Wayne County because nearly all of the concrete highways in Michigan are still confined to that county, though several pieces have been built outside.

Concrete roads are no longer looked upon as an experiment, and deserve serious consideration in determining the type of highway which is to be built whenever a community can afford to expend from $10,000 to $15,000 a mile in road construction.

The writer for a long time has been preaching the doctrine, that no one type of road is the best road in all places and under all conditions.

Michigan roads carry a traffic of from upwards of 2,000 vehicles per day down to less than 10. The state has soils ranging from light dune sands to heavy black clay loams which become long lines of liquid morass in continuous wet weather. It has counties with rated valuations of from over $500,000 per road mile as in Wayne County, down to about $5,400 per mile in the poorer counties like Lake—a difference of nearly one hundred to one.

One county pays more than one-quarter of the state taxes and the other but little more than one one-thousandth of the state taxes, yet the people of both counties want their roads improved. No one could seriously object to the rich county building concrete roads at a cost of approximately $15,000 a mile, and the poorer county building gravel roads

at a cost of $1,500 a mile, but even these rates of cost are not proportionate to the ability of the two counties to pay for their roads.

The former county builds a road which satisfies its people, is in every way meeting its soil and traffic conditions, and is well inside its financial ability; while the latter county, by building the cheapest good road it can, also gets one which stands up equally well on its sandy loam soil and under light traffic, but has stressed its financial ability more than twenty times as much as the richer county. No sane and disinterested person could advocate concrete or any other expensive type of road where conditions approximate those in the last named county.

Nevertheless, concrete roads are growing in popularity in Michigan, and the writer believes deservedly so. Up to December 1st, 1914, 104 miles of state reward concrete road had been built in my state in seven counties, although all but 7 miles are located in the County of Wayne.

The writer is firmly of the opinion, however, that the first few miles, say from two to five miles out of each large market town, should be built of a more permanent type of road than is usually chosen.

However, such catch phrases as "The best is not too good," and "The most expensive road is the cheapest in the long run," often used by road promoters, must always be taken with the proverbial "grain of salt" for economic reasons which are obvious to the road engineer.

It has been charged by some opponents of the concrete road that it will be short lived and that if it does not break up under traffic, it will crack so badly in a few years by action of the elements that it cannot possibly be a long lived structure.

The writer became convinced several years ago that a well built concrete road will not wear out under heavy country road traffic in a single generation, but was not so certain that the elements would not get the best of it in a few years, and that it would become so badly broken up that it would have to be rebuilt or rejected entirely.

Accordingly in September, 1913, arrangements were made with the Road Commissioners of Wayne County for a systematic count of the defects in every slab covering some thirty miles of concrete road in that county. This was done with a view of keeping it up for a period of several years for the purpose of making a reasonably accurate estimate as to the probable life of such roadways.

TABLE 1—WAYNE COUNTY CONCRETE ROADS.

Name of Road.	No. of 25-ft. sections.	Width.	Depth.	Aggregate.	Mix.	Year built.	Soil built on	Traffic count 24 hours—average, one week.	% Motor-driven.	% Horse vehicles.
Woodward Ave.................	209	18′	6½″	†C.C.S.	{1-2½-5 1-2 -3}	1909	Clay loam	2,160	88.1—	11.9+
Woodward Ave.................	252	18′	6½″	†C.C.S.	{1-2½-5 1-2 -3}	1910	Sand loam	....	...	...
Gratiot Ave...................	326	16′	7 ″	*W.P.S.	1-1½-3	1911	Clay loam	507	65.8+	34.2—
Grand River Ave..............	61	18′	6½″	†C.C.S.	{1-2½-5 1-2 -3}	1909	Clay loam	1,064	56.5+	43.5—
Grand River Ave..............	341	16′	6½″	†C.C.S.	{1-2½-5 1-2 -3}	1910	Clay loam	....	...	...
Grand River Ave..............	515	16′	7 ″	*W.P.S.	1-1½-3	1911	Sand loam	....	...	...
Grand River Ave..............	1,208	16′	7 ″	*W.P.S.	1-1½-3	1912	Sand loam	352	66.5—	33.5+
Michigan Ave..................	481	17′–8″ 18′	6½″	*W.P.S.	1-2 -4	1910	Clay loam	1,009	67.5+	32.5—
Michigan Ave..................	1,570	16′	7 ″	*W.P.S.	1-1½-3	1911	Sand loam	....	...	...
River Road....................	149	15′	6½″	*W.P.S.	1-2 -4	1910	Clay	5.38	78.9+	21.1—
River Road....................	434	15′	7 ″	*W.P.S.	1-1½-3	1911	Clay	....	...	...
River Road....................	213	15′	7 ″	*W.P.S.	1-1½-3	1912	Clay	....	...	...
River Road....................	208	15′	7 ″	*W.P.S.	1-1½-3	1912	Clay	....	...	...
Fort St. Road.................	450	12′	7 ″	*W.P.S.	1-1½-3	1912	Clay	....	...	...

†Crushed Cobble Sand.
*Washed Pebbles Sand.

Table 1—(Continued)

Name of Road.	Longitudinal cracks. '13	Longitudinal cracks. '14	Transverse cracks. '13	Transverse cracks. '14	Diagonal cracks '13	Diagonal cracks '14	Holes. '13	Holes. '14	Totals. '13	Totals. '14	Grand total. No.	Defective slabs, 1913. No.	Defective slabs, 1913. %	Defective slabs, 1914. No.	Defective slabs, 1914. %	Increase defective slabs, one year. No.	Increase defective slabs, one year. %
Woodward Ave.	80	28	32	18	2	2	46	17	160	65	225	129	61.7	152	72.7	23	11.0
Woodward Ave.	29	23	22	5	6	2	18	11	68	48	116	59	23.4	93	36.9	34	13.5
Gratiot Ave.	11	8	10	5	3	7	6	38	30	58	88	28	8.6	71	21.8	43	13.2
Grand River Ave.	11	5	2	4	1	2	3	11	17	22	39	14	22.9	26	42.6	12	19.5
Grand River Ave.	59	64	20	13	29	36	46	36	154	149	303	102	29.9	167	49.0	65	19.1
Grand River Ave.	13	2	26	7	3	2	6	60	48	71	119	45	8.7	111	21.5	66	12.8
Grand River Ave.	70	17	44	20	13	7	5	28	132	72	204	126	10.4	180	14.9	54	4.5
Michigan Ave.	219	54	48	6	23	10	21	5	311	75	386	252	52.4	288	59.9	36	7.5
Michigan Ave.	219	77	80	38	42	24	14	9	355	148	503	311	19.8	415	26.4	104	6.6
River Road.	49	11	5	0	6	3	2	12	62	26	88	57	38.3	72	48.3	15	10.0
River Road.	165	27	17	18	13	27	0	7	195	79	274	184	42.4	224	51.6	40	9.2
River Road.	14	4	8	8	4	3	0	8	26	23	49	21	9.8	52	24.4	31	14.6
River Road.	17	7	9	21	0	0	0	1	21	29	50	25	12.0	44	21.2	19	9.2
Fort St. Road.	0	1	19	11	9	1	1	31	29	44	73	27	6.0	66	14.7	39	8.7

The record made at the time of that count was tabulated and presented by the writer in a paper on concrete roads to the American Road Congress held in Detroit, October, 1913. A second count was made of the defects in these slabs one year later, September, 1914, and I wish to make a brief mention of the result of this second count at this time.

The accompanying table reproduces the old table to the extent of giving the location of the road; number of twenty-five foot sections observed on each road; width and depth of concrete; aggregate and mix used; year built; soil built on, and a traffic record. The defects are classified as longitudinal, transverse, and diagonal cracks and holes. The table shows the number and kind of defect noted in each of the two years; the total number of defective slabs up to date and at the time of each count; the per cent. of defective slabs at each count, and the increase in numbers and percentage of increase during the past year.

The oldest road covered by these observations consists of 209 sections of 18-ft. roadway on Woodward Avenue, built in 1909. Last year, 61.7 per cent. of the slabs were defective and this year 72.7 per cent., showing an increase of 11 per cent.

This is the oldest road and shows the greatest per cent. of defective slabs, but it does not show so great a per cent. of increase in defective slabs as do some of the other roads, for six other roads show a greater per cent. of deterioration, though none of them had a total of over 49 per cent. of defective slabs.

It might be argued that if the defects increase on this Woodward Avenue Road at the same ratio for three more years, there will then not be a perfect slab in the entire pavement. This might be true, but careful examination of the present condition of the pavement and the methods of keeping it in repair will readily convince one that, even if every slab were as defective as the worst slab is today, the pavement would still be good for many years.

The writer is pretty well convinced that the cracks and other defects noted thus far are not much more serious than the expansion joints, laid transversely every 25 ft., for every year the transverse joints, cracks and other defects are cleaned, filled with a very heavy grade of refined tar, and sanded. This treatment has so far proven such an excellent preservative of the pavement as a whole that the defects noted may be considered more as marring the appearance of the pavement than something which will soon cause its destruction.

Time will not permit a more extended study of this table, but the writer is becoming convinced that even at the present ratio of increase in the defects noted, if the present methods of repairs are maintained, these concrete pavements will last as long, and possibly longer than most other kinds of high grade pavement, and really have proved an economical investment for the county when the first cost, interest on the investment and cost of repairs are all considered.

I might say a blue print is attached to this paper and if any of you desire the blue print it will be mailed to you from our office on application. (Applause.)

PRESIDENT McLEAN: The discussion will be continued by Mr. Henry G. Shirley, Chief Engineer of the Maryland State Highway Commission. Mr. Shirley. Mr. Shirley apparently is not here.

The next speaker is Mr. P. C. McArdle, Acting Chief State Highway Engineer of Illinois. Mr. McArdle. (Applause.)

P. C. McARDLE (Acting Chief State Highway Engineer of Illinois): Gentlemen: I am somewhat in the same position as our friend Rogers. I received yesterday afternoon the paper which I have to discuss today and I have not prepared anything definite in written form to present; but I take pleasure in discussing in more or less detail the suggestions presented in Mr. Kuelling's paper.

Perhaps no form of road building has taken hold of the American people to such a wide extent as the concrete road. I am not here to advocate any type of road, concrete or any other, but I must admit that for the money paid for concrete roads it is unquestionably coming rapidly into the forefront as as country highway.

Mr. Kuelling stated in reference to his road bed that he did no rolling. Our practice is a little different. We do the rolling and do very much rolling, and we have reached the point today where we do a little more than rolling if our concrete road is to be a success and if the defects that have developed heretofore in concrete roads are to be prevented in the future. I refer to the fact that concrete roads, particularly on cuts and fills, should be puddled as well as rolled and that puddling is a necessity not only on the fill but also on the old grade, if there is an old grade, to find the soft spots in it and so fill up, and prevent the necessity for bridging. Bridging, I think, is one of the

causes for longitudinal cracks—the most unsightly defect known in concrete roads.

In counties surrounding cities of large population, such as Cook County, there can be no question of what the width of the road should be. We are satisfied now that a width of a road for a double track should be 18 ft. at least, based upon the fact that in this city and other cities of like size or smaller, that the auto truck is developing very large dimensions, and if you will step out to the machinery hall you will find one of extremely large dimensions. Trucks of that kind are going to travel at a speed that will be economical, and they will need at least an 18-ft. pavement. Outside of the larger counties, such as Cook County and the adjoining smaller centers of population, I don't believe an 18-ft. road is necessary. Surrounding cities like Peoria and within a radius of two or three miles, an 18-ft. road should be built. Further out a 10-ft. road would be ample to take care of the traffic, particularly high speed traffic. It is a fact, in our construction this year, on the request of the county board, we were required to place beside our 10-ft. concrete road a shoulder of macadam, a 4-ft. shoulder on either side of the concrete road. These shoulders so far have not proven an extraordinary success, to say the least. On the 18-ft. road in the larger counties adjoining the greater cities, the earth shoulder described in Mr. Kuelling's paper appears to us the proper thing. There is no necessity for a macadam or a gravel shoulder on the 18-ft. concrete road. Eighteen feet will be ample to take care of the traffic, considering the fact that the motor traffic is rapidly increasing, and the higher speed of the concrete road over the gravel earth road will give added capacity to the 18-ft. road. There has been some discussion that 18-ft. roads would be too narrow for Cook County. I doubt that theory. I am also quite satisfied that there is no interest that would demand less than 18 ft. However, in the smaller sections of the state I am also just as convinced that the 10-ft. concrete road, when it is decided to replace an earth road, as our construction designs now show, would take care of the heavy traffic all times of the year. I refer to one road in particular in Champaign County. In the center of the road is a 10-ft. brick road and on each side 10-ft. earth roads. I saw on that road this fall three lines of traffic operating successfully. Wagon traffic was using the earth roads, traveling in each direction, and automobile traffic the brick road.

Discussing the thickness of road, for some reason or other, probably to prevent longitudinal cracking, our depart-

ment has designed our concrete roads 18 ft. wide, of the same thickness as the Wisconsin designs, 6 ins. thick at the sides, 8 ins. at the center, on a flat subgrade. So far, covering construction this year of 70 miles of concrete and brick roads, we have yet to find one known to have cracked longitudinally.

In the matter of concrete roads too much care cannot be given to the selection, the testing and the examination of the cement used, for it is a foregone conclusion that if the cement is wrong to begin with, the road must be wrong when it is finished. So much has this convinced us that we have adopted the methods of testing required by the Bureau of Standards at Washington in our tests. Our own department was organized and all the cement used on our concrete roads is tested by our department, and this year we have used, within 60 days, 165,000 barrels of cement.

In the matter of coarse aggregate: We, in Illinois, are not so favorably located as is Wisconsin in the matter of first class materials for concrete aggregates. In some sections we are in about the same position, but in many others we are not, and we have attempted to use the best of the material at hand. We have required in our specifications the same coefficient of wear as described by Mr. Kuelling in his paper, a French coefficient of 10, but added to that a test for toughness, and by putting these two together it should be 16.5. However, our experience in testing with the French coefficient is this, that the French coefficient, as now made, is practically impossible to carry out successfully. For instance, in much of the crushed stone we had to use a stone that showed a French coefficient of 8 and 9, and we found in making the test for toughness that some stones that showed the coefficient of 3½ showed a toughness of 13. It was absolutely unsuitable, but it showed that the tests now carried out are not the ideal tests to determine the proper quality of an aggregate. I am taking issue now with the United States Government. The test they use, or the French coefficient alone or combined with toughness, is not the proper test or the proper way to determine the faults of stone for concrete road building. A further illustration of that will be, one quarry submitted a sample of some 50 pieces of stone weighing about 30 pounds, as required by the Office of Public Roads, Department of Agriculture. The test was made in our own laboratory and showed a coefficient of 16½. I immediately wrote to the proprietor of the quarry and stated that our department would require his quarry to deliver all stone coming from

that quarry to have a French coefficient of 16½. He responded saying he did not wish that. He sent a new sample, and it tested 10. An explanation of that will be necessary. The first sample he submitted he selected carefully. He went into the quarry and broke off a number of pieces with a hammer, 50 in all, varying little in size from a 1½-in. cube. Of course, he then sent them to the laboratory. When they got there, the edges were not there to grind off. The second, he went to the crusher and selected pieces with angular edges. The result was, in the second stone from the same quarry, the French coefficient was 10 instead of 16½.

I want to say further that we in Illinois wish to use our own materials as far as possible, as far as is consistent with good practice. We are compelled to use here such materials as limestone or gravel. In some parts of Illinois we have pits properly equipped to screen and wash gravel. In some cases it is difficult to get materials that are absolutely fit, but we have got samples of both gravel and stone this year in actual service which will determine, to a large measure, whether we will continue to use crushed stone or not. We have samples in Sangamon County, from several quarries standing side by side with gravel on the same soil. These experiments, as I may call them, are to determine whether gravel or crushed stone is better or if both are equally suitable. One illustration along this line is interesting: One of these roads has shown 12 cracks in a distance of 3,500 ft. The joints are made 100 ft. apart. The other road, built of crushed stone coming from a Southern quarry, is the same length, and has no crack at all, all done under the same conditions, with the same division engineer in charge—the same conditions as nearly as they could possibly be.

I may say also that the same requirement as to dirt and the fine aggregate pertained in Illinois as in Wisconsin. We in Illinois have drawn a specification that excludes altogether pit run gravel, and very rightly so. They have succeeded in developing quite an industry in the gravel business and we rather encourage the business to produce materials to satisfy our specifications which are rather rigid.

In the matter of reinforcing, we agree with the methods given by Mr. Kuelling. In only one section of the state have we prescribed reinforcement. On that road we are making an experiment requiring 800 ft., to be placed without joints.

We have not yet reached, however, the position that we require the delivery of the concrete to the road by chute.

I feel that the delivery by chute will put us in the position of getting too much water in the concrete. I have watched the materials and methods during construction very carefully this year, going over the road with the division engineers, and I have observed the work afterwards, and in those cases where I had my attention called to excessive water, it seemed as though the excess water never was taken off properly. On the other hand, where the water was checked at the proper time, the same contractor produced a road several thousand feet long without a crack. The manner of reducing the percentage of water is, to my mind, the most important proposition in concrete road building before the engineering fraternity today. The State Engineer of Oregon designed a roller for this purpose. He has described this method in a recent issue of the "Engineering Record," and perhaps has reached success. Some others have a shaking method of reducing the percentage of water. But I am satisfied that the joints do no harm if the pavement is made dense enough through tamping or rolling. And I call the attention today, if those machinery men are interested, it would be a valuable point to make up a machine that would finish the road mechanically and compress it mechanically, to prevent the flooding at all. The flooding proposition has been responsible for pockets in almost every road constructed of concrete.

In the matter of curing concrete in roads, it has been carried on in precisely the same manner as in Wisconsin. In the matter of joints, last year and the year before our department placed joints 50 ft. to 75 ft. apart. This year they have placed the joints 100 ft. apart, and in no case have they used, with the exception of one short section, any armored joints. Our experience with the roads that have been opened 60 days this year has satisfied us that our decision is right, and that is that the armored joint is not worth the price we have to pay for it because we have to maintain the armored joint just as much as the other joint.

Too much stress cannot be placed on the matter of inspection and care in the construction of the concrete road. There is no road built that needs the care that a concrete road does. No road needs a better, stronger character to carry it out, because every detail of the work must be right or the road is wrong.

I may say that our department has undertaken to tabulate defects in all our concrete roads according as they are built. When the final report is made to me or the department, on any section of road, the division engineer and resident en-

gineer on the work must prepare a drawing showing the defects in the road at the time they submit it for final inspection. The reason is that hereafter as the years go by, the inspectors will note from year to year what the defects are so that we can tell definitely when the road is going to fail and why.

In conclusion, not to take up too much time on my extemporaneous attempt, I wish to say that I don't want to be taken as advocating concrete roads in particular. We have need in Illinois for all kinds of roads. We have a total mileage of 95,000 in Illinois that need to be improved, some will be earth, some macadam, some water bound, some bituminous. We have 25,000 miles of state aid roads. These roads must be of some good material. We started in this year and determined that these main market roads should be either concrete or brick, so that we may not be entirely on the run in maintaining them. We realize that a concrete road must be maintained, we realize that that maintenance will be considerable, but we know that the maintenance of a concrete road will not be as much as the maintenance of a macadam road, and that a concrete road will be in existence many years after a macadam road at the same cost, in the form of dust, has gone to the fields from whence it shall never return. (Applause.)

Just a moment, gentlemen. The question is asked what type of concrete is used. It is one-course concrete throughout.

PRESIDENT McLEAN: Before throwing the discussion open to the house I wish to tell you that an invitation will be extended to the members of this Association to go through the Stock Yards. It is probable that the time will be between twelve and two o'clock tomorrow, but the invitation will be extended when the session opens at ten o'clock in the morning and the hour will be fixed at that time.

There will be a meeting this evening, in Room No. 808 at the Hotel La Salle, of the Board of Directors.

Through some oversight or some uncertainty as to the Committee on Credentials having been appointed, I will ask the Secretary to announce the names which were intended to be included.

SECRETARY POWERS: A. M. Jackson, J. M. McCarthy, P. C. McArdle, R. Keith Compton, Frank F. Rogers, H. W. Durham and E. D. Brian.

PRESIDENT McLEAN: If that committee will arrange to meet any time after the present, so that they may report,

I will ask Mr. Jackson, the Chairman, to receive the other members in the room adjoining.

Now, we are free to return to the discussion from the floor on the subject of bituminous construction for a short time. Gentlemen, the subject is open. Don't hurry. This is an interesting subject.

As no one apparently desires to ask questions or make any statements, we will turn to the subject which we have just had under consideration, concrete roads. Is there any discussion from the floor on that subject?

H. C. FRENCH (Superintendent, Cadwell Sand & Gravel Co., Windsor, Ont.): I have a question that I would like to put before some one who would answer it. In the papers that have been given us on concrete roads, the fine aggregates have been specified as running from ¼ in. to nothing. I am curious to know what is meant by nothing and where that nothing may start and where it may end. In other words, I believe the Wayne County specifications read that the fine aggregates shall run from ¼ in. to nothing, but it adds that the coarser particles shall predominate. To just what extent these coarser particles shall predominate is left entirely to the judgment, I presume, of the inspector. It has been quite a contention with us as to how much of this sand should pass a 50, how much should pass a 20, and how much should be retained on these various sized screens to make a proper mix. I speak now of a sand that contains practically no loam and is practically entirely silicate in its formation. I would like to hear from some one who is an authority on that subject.

PRESIDENT McLEAN: Is there any one here who can respond in connection with the roads of Wayne County, as to the interpretation of their specifications in that regard? Is Mr. Hines here?

WM. M. KINNEY (Engineer, Information Bureau, Universal Portland Cement Co.): In connection with our inspection of concrete road construction during the year 1914 we have tested a large number of samples of aggregate, probably close to 1,000. We have come to the conclusion that it is a very difficult matter at this time to specify just what percentage of materials shall pass certain sieves. However, we have established in our own minds that fine aggregate, 3 per cent, of which would pass a 100-mesh sieve and 20 per cent, of which would pass a 50-mesh sieve, would not be entirely satisfactory for concrete road work. The value of a fine aggregate should not be judged by a granulometric analysis alone, but a study should also be made of the

tensile and compressive strength in 1:3 sand mortars. We are strongly in favor of the compressive strength tests, and in this work use the 3 in. by 6 in. cylindrical specimen.

All of the laboratory tests are considered in determining the suitability of a particular sample and it is a study of the complete results rather than a compliance with particular requirements which influences the decision.

PRESIDENT McLEAN: Is there any one else who can give us some information on that point? A certain standard, I believe, was fixed in the specifications and accepted here a year ago, approximately, in February, by the National Concrete Association. I can't tell you at the present time from whom the report could be obtained, but possibly some one else here can say. The address is in Chicago.

MR. KINNEY: Copies of these specifications may be obtained from the Association of American Portland Cement Manufacturers, Bellevue Court Building, Philadelphia, or the Universal Portland Cement Company, 208 South La Salle Street, Chicago.

PRESIDENT McLEAN: That may possibly afford some information.

MR. EZRA STOLTZFUS (Gap, Pa.): Might there not be a possibility of deviation in the size of stone and sand even if they go through the same sieve, that is, to fill up the voids? The main thing is, I guess, in making concrete to have enough of sand or small stuff to fill up the voids, as I understand it.

PRESIDENT McLEAN: I would assume that some latitude would be allowed there.

Mr. STOLTZFUS: That would have to be left to the judgment of the user.

MR. FRENCH: I have another question as to whether or not any one has had a sufficient amount of experience in the difference between lake sand, that is lake gravel-sand, or sand taken from the gravel that is taken out of the lake, and the pit gravel sand that has been washed, to notice whether there is any difference in the wearing surface or the tensile strength between the two kinds of sand.

PRESIDENT McLEAN: Is there any one on the floor who can answer that question? Have any tests been made or has any close observation been recorded as to the difference in lake sand and pit sand for construction?

GEO. A DINGMAN (Engineer, Board of County Road Commissioners, Wayne County, Mich.): I don't know whether Mr. Hines is here or not. If he is he might answer.

PRESIDENT McLEAN: I believe Mr. Hines is not here.

MR. DINGMAN: I know that we have rejected lake sand on account of too much of it being flat. We prefer to use the washed bank sand. We find on some roads where lake sand was used that it is wearing away more appreciably.

MR. KINNEY: Whether a lake sand is superior to a bank sand depends entirely on the particular sand in question. Under normal conditions a lake sand would be cleaner, but on the other hand, might contain considerably more fine material than a bank sand. In each locality the deposits must be studied and decision based upon this study. The American Society for Testing Materials has within the past year appointed a committee to look into the question of tests on aggregate, and, as a result of their work, there should be in the next year or two a distinct advance in the knowledge on this subject.

PRESIDENT McLEAN: My own department is just starting such a series of tests but we aren't ready to say anything at the present time. Mr. Brian, have you any experience on that?

M. E. BRIAN (City Engineer, Windsor, Ont.): I haven't had much experience with pit sand. I have used nothing but lake sand. We haven't any pit within probably 20 miles. We had a test made of one pit and it showed 3 per cent. of clay. Fortunately we got very fair lake sand. We wouldn't care to use the pit sand unless washed.

F. E. ELLIS (Manager, Essex Trap Rock & Construction Co., Peabody, Mass.): I would like to know if anyone has made any test as to the value of stone screenings as a substitute for sand, either granite or limestone, where the particles are graded the same as required for sand.

PRESIDENT McLEAN: Has any one had experience in the point placed before us, that is, the use of screenings instead of sand in the construction of concrete pavements?

C. D. FRANKS (Universal Portland Cement Co.): It has been my experience in watching the construction of a large yardage of concrete pavement that there has developed the preference of either bank or lake sand over screenings. The reasons for this are that the grading of the sand is better and that screenings have a tendency to ball up in the mixer, causing trouble, which is not experienced in using sand. Then, again, when the proper mix is used, you will find a smaller moisture content in sand concrete after hardening and after it has been subjected to various atmospheric conditions. The moisture content of concrete affects to a considerable extent the amount of expansion and contraction.

MR. KINNEY: Mr. Chairman, I don't want to take up all the time in the discussion.

PRESIDENT McLEAN: That is all right, Mr. Kinney. We are pleased to hear from you.

MR. KINNEY: Laboratory tests seem to indicate that stone screenings give very good strength; however, results in the field do not always bear out this conclusion due, no doubt, to the mechanical interference to good mixing. The fine dust and small angular particles do not seem to mix so readily and it would seem that a greater length of time for mixing might be required where screenings are used. On many jobs, however, screenings from which the fine material passing the ⅛-in. screen has been removed, might be a distinct advantage, and such screenings, mixed with an equal part of sand, would make an excellent fine aggregate, as sand is usually deficient in coarse particles. Such use might be taken care of practically by having three aggregates rather than the customary two on the job. For a 1:2:3 mixture the proportions might be as follows: one part cement, one part sand, one part stone screenings and three parts coarse aggregate.

H. A. LUMSDEN (Department of Public Works, Province of Ontario): I would like to know if any one has had any experience with hydrated lime in cement.

PRESIDENT McLEAN: Can any one speak of the use of hydrated lime in cement concrete construction?

MR. KINNEY: To my knowledge there are very few concrete roads in the United States or Canada in which hydrated lime has been used. An experimental stretch of approximately 400 ft. was laid on the Chevy Chase Road by the United States Office of Public Roads, and the conclusions from this experiment are contained in their Bulletin No. 105, Page 16. Apparently there is no difference between this section and one of the same mix in which no lime was used. It would seem that the use of a third material on a concrete road job should present well established advantages in order to justify the disadvantages

J. B. MARCELLUS (Road Engineer, Association of American Portland Cement Manufacturers): As a matter of information, the Park Board of St. Louis has built perhaps five or six hundred feet using various percentages of hydrated lime. This varies from 5 to 15 per cent. It was just put in this last fall and of course no results have been obtained. They made some cubes, however, from this material and the cubes showed a decrease in strength with the increased addition of the lime.

MR. BRIAN: I think it is three years ago now that the Department of Public Works of Ontario built a concrete road on Tecumseh Road, near Windsor, and about one-third of it was built with the addition of 10 per cent. of hydrated lime, I believe. I have been over it many, many a time, and the experience I have found with that road is that with the addition of hydrated lime there are less cracks in that third than in any other portion of the road. The rest of it was made without the hydrated lime and a considerable number of cracks developed.

PRESIDENT McLEAN: I might add to the outline that Mr. Bryan has been good enough to give; that in 1913 we also constructed a section, using the same proportions, about 10 per cent. of hydrated lime, in Ontario. The road is approximately 8,000 ft. in length, and to the present time I haven't been able to discover a single crack in the work. It is too early, however, to speak with any authority. It takes time to develop that. Is there anything further?

L. REINECKE (Geological Surveyer of Canada): I want to ask the men who have built concrete roads as to just how far the coating of lime found upon certain pit gravels condemns the gravel for concrete work. I have understood that it condemns gravel, but others do not think so. Will some one tell me just what effect it has?

MR. FRANKS: I have had occasion to use lime coated gravel in the construction of highways and so far have noted this effect, that the coarse particles or particles which lie near the surface of the finished pavement have a tendency to pick out of the surface, leaving small pit holes in the surface of the finished roadway. That has been my observation in using lime coated gravel in construction. I would seriously question the use of lime coated material if it were possible to get away from it. It might be remedied by using two-course construction, using a different kind of aggregate for the wearing course and using the lime coated material in the construction of the base.

MAJOR CROSBY: May I ask with what authority the gentleman referred to a coating of "lime?" In other words, what tests of that coating were made which showed it to be lime? I ask for information.

MR. FRANKS: There were no particular tests made by myself or the engineers in charge, but the material that I speak of came from the Elkhart River in the State of Indiana, also from the river at Anderson, Indiana. The only reason that I suspected it was lime was the fact that it was

said to be lime by local engineers at Elkhart. Further than that we made no test. It had the appearance of being lime from its general color.

MAJOR CROSBY: I wish to emphasize the necessity of being quite careful in making statements in the discussion that this appears to have raised because of the extreme difficulty in deciding this fine question. The fact that a bank gravel may stand for some time with a vertical face does not necessarily indicate that there is lime in the bank. An excess of lime in the cement or in the concrete would produce probably deleterious effects in the final results secured so that I should say considerably more information than has been furnished so far, is likely to be needed before a correct determination can be made as to the effect of this fine whitish material. The point is an extremely interesting one and it would be of the greatest possible value to us all if these gentlemen who have the opportunity to investigate accurately the conditions existing in these banks would make such investigations and present the facts carefully and thoroughly at the next convention of the Association, for instance, when I think that the point would be of the greatest possible interest. It has started in my mind a very interesting train of thought and I would like to see it developed.

MR. FRANKS: Mr. Chairman, the principal thing to bring out, however, is the fact that whether or not this coating is lime, we still are face to face with the fact that the lime coating on the gravel particles scales off, thus preventing a perfect bond between those particles and the surrounding mortar which naturally, if the particles were close to the surface, under a severe abrasion would cause them to chip out and leave pit holes in the surface. That was the main point I wanted to bring out. However, the gentleman's suggestion is a very good one.

C. B. ANDERSON (Joplin, Mo.): I would like to inquire if there is anyone here that has ever laid any concrete streets with Joplin, Missouri, chats, a product of those mines.

PRESIDENT McLEAN: Has any one laid concrete out of Joplin, Missouri, chats?

A. W. VAN HAFFTEN (President, Gopher Mining & Manufacturing Co., Minneapolis, Minn.): For those who do not know what chats are, I wish to state that all zinc and lead mines in the Joplin, Missouri, district produce chats. In crushing out the zinc and lead ore from the ore-bearing rock, the waste product is known as chats. This waste product is a hard gray or blue limestone carrying considerable flint rock. In concentrating the ore, the rock is crushed

so that it will pass through a ¼ to ⅜-in. screen. A certain amount of rock or mine sand is also produced, and is mixed with the waste in proper proportions to make excellent concreting material. I wonder if any one has had any experience with this material in the construction of roads.

J. W. LOWELL (Universal Portland Cement Co.): Mr. President: During 1912 and 1913 some concrete pavements were built at Carlinville, Ill, with chats or stampings from the lead mines in Missouri. I have seen two kinds of chats from Missouri, one is of dark gray and the other of white flinty stone. The chats used in the Carlinville pavements were the kind first mentioned. In 1912 the chats used were of such size as to practically all pass a No. 4 sieve, while those used in 1913 contained about 25 per cent. by weight between ½ and ¼-in. chips. All of this material was deficient in particles through a No. 20 sieve, which practically excludes the material from the class of fine aggregate. This was further evidenced by the fact that mixtures of cement and chats would not trowel well, due to lack of fine material.

The concrete mixture used at Carlinville was 1 part Portland cement, 1½ parts sand, and 3 parts chats, and the volume of resulting concrete from a mixture of these proportions was about 20 per cent. more than the volume of chats. This rather small increase in volume was due to the very fine sand used, all of it passed a No. 10 and most of it passed the No. 20 sieve. It is my opinion that the strength of this mixture would really be equal to a 1:3 cement and sand mortar of equal age, and perhaps a little stronger, but not nearly so strong or durable as a 1:1½:3 concrete composed of similar quality coarse aggregate stone graded in sizes from ¼ in. to 1½ ins.

It is my belief that chats can be used as an aggregate and with good results, but they cannot be substituted for standard proportion mixtures based on larger and better graded aggregate. Chats may be mixed with fine sands such as was used in Carlinville to improve the strength of the fine aggregate, the proportions of the materials being established in each case by sieve analysis tests. For some classes of construction it is possible that they may subtitute coarse aggregate if a larger proportion of cement is used, the proportions being established by tests with such aggregate. Whether this would be practical would depend upon the comparative cost of concrete of this character and concrete of the same strength made from recognized quality of aggregate.

MR. VAN HAFFTEN: I wish to state that there are about 2,000,000 cu. yds. of chats lying as waste in Southwest Missouri, and a large quantity is being made daily. Mine operators would like to find a market for it. They are almost willing to give it away or for the cost of handling it. This would be about 12 to 15 cts. per cu. yd., and covers the expense of handling and loading the chats at the mines. They have used chats locally, and they have shown excellent results; e. g. some concrete bridges have just recently been completed in which nothing but the chats and its sand were used. The proportions of rock and sand in the chats were ideal for concrete work. I do not know, however, to what extent chats have been used in road construction, but am interested to know because there is a big field for an inexpensive pavement where chats could be used.

MR. LOWELL: I have heard that chats can be bought from mine operators at loading cost. If this is so, an extensive investigation of the usefulness of the material should be made.

The numerous inquiries referring to chats as an aggregate for concrete which have come to the Information and Inspection Bureau of the Universal Portland Cement Co. have caused that organization to undertake some investigations because no data could be found. This investigation is now being conducted at the Structural Materials Laboratory, of Lewis Institute, Chicago, and before long it is possible that something may be known of the usefulness of chats.

MR. VAN HAFFTEN: At the Gopher Mine I am turning out as waste product alone about a thousand yards of chats every day. I would like to see a general use made of this material, as it is plentiful and the supply is continuous.

MR. MARCELLUS: In answer to the gentleman over there, I have seen most of the concrete pavements in the Missouri Valley and I have seen some made from chats, but most of them have been used in a two-course pavement. I refer particularly to Atchison, Kan., St. Joe, Mo., and Clinton, Mo. So far the results have been satisfactory. However, on the job at Clinton, Mo., the continuous mixer was used, and results were not so satisfactory.

PRESIDENT McLEAN: Gentlemen, there is room for extremely interesting discussion, but unfortunately, the time has come when we will have to resolve ourselves into the business session as announced. I hope that all the members of the American Road Builders' Association will stay for that session.

Business Session

PRESIDENT McLEAN: The reports of the committees are in order. The first report will be that of the Committee on Standards, Mr. N. P. Lewis, Chairman. Is Mr. Lewis here?

MR. DEAN. Mr. Chairman: Mr. Lewis had to leave, but he left his report with me and I handed it to the Secretary

PRESIDENT McLEAN: The Secretary will kindly read the report.

[Secretary Powers then read the report, which follows:]

Report of the Committee on Standards

To the American Road Builders' Association:

Gentlemen: Your Committee on Standards, which was appointed at the Philadelphia Convention, submits the following progress report:

The Committee organized for its work by the appointment of sub-committees upon the following subjects:

1. Field tests for materials used in street and highway construction, which tests may be made on the ground by superintendent and inspectors.
2. Specifications or instructions for the building of earth and gravel roads.
3. Specifications or instructions for the building of sand-clay roads.
4. Specifications or instructions for inspectors and foremen engaged in maintenance and repair work.
5. The care of the roadside.
6. Dust preventives.
7. Traffic standards.

As the members of your Committee are widely scattered, from New York to California and from Michigan to Texas, it has been impossible for the Committee to have a meeting since the Philadelphia Convention, but the sub-committees were so arranged as to group together in each committee members who were as conveniently located as possible with respect to each other. Nearly all the sub-committees have submitted reports, some of which are brief, and others are quite voluminous. The Committee, as a whole, has had no opportunity to condense these various reports and combine them in a single report of the Committee.

We recommend that the Committee be continued; that it submit its report to the Annual Meeting to be held in February, and that, if the Association so directs at that Annual Meeting, its report be printed in the proceedings of the present convention, so that it may be available for all members of the Association; that comment and criticism be invited from the membership and that the Committee submit a final report at the next convention, at which time the Association, after an opportunity for discussion, may take definite action upon the recommendations of the Committee.

Your Committee feels that the Association should only adopt standards for the various divisions of highway work above out-

lined after careful deliberation and thorough discussion, and that the Association should not be asked to pass finally upon such standards until the report of the Committee shall have been before the members for a sufficient time to permit such careful consideration and criticism.

Respectfully submitted,
(Signed) NELSON P. LEWIS, Chairman.

[The Committee on Standards consists of Nelson P. Lewis, Chief Engineer, Board of Estimate and Apportionment of New York City, Chairman; H. L. Bowlby, State Highway Engineer of Oregon; A. W. Dean, Chief Engineer, Massachusetts State Highway Commission; A. B. Fletcher, State Highway Engineer of California; S. D. Foster, Chief Engineer, Pennsylvania State Highway Department; C. A. Kenyon, President, Indiana Good Roads Association; W. A. McLean, Chief Engineer of Highways and Commissioner, Ontario Public Roads and Highways Commission; R. J. Potts, formerly Professor of Highway Engineering, Agricultural and Mechanical College of Texas; Dr. Joseph Hyde Pratt, State Geologist of North Carolina; F. F. Rogers, State Highway Commissioner of Michigan, and Geo. W. Tillson, Consulting Engineer to the President of the Borough of Brooklyn, New York, N. Y.]

MAJ. CROSBY: Mr. President, I move the report be adopted.

MR. MEEKER: I second the motion.

PRESIDENT McLEAN: You have heard the motion. It is moved and seconded that the report be adopted. Any discussion? All those in favor of the motion will say aye. Opposed no. The motion is carried.

The next will be the report of the Committee on Legislation.

[Secretary Powers then read the report of the Committee on Legislation, which follows:]

Report of the Committee on Resolutions

To the American Road Builders' Association:

Your Committee on Legislation begs to report that, in pursuance of its instructions, a study of road laws has been made, and a tentative statement of principles, based thereon, has been prepared. Your Committee, however, is of the opinion that further investigation should be made before a final report is presented to or adopted by this Association; and authority is desired to present such report for discussion or adoption at the next annual meeting, when publication may, if then deemed advisable, be authorized in the report of that convention.

(Signed) W. A. McLEAN, Chairman.

[The Committee on Legislation consists of W. A. McLean, Chief Engineer of Highways and Commissioner, Ontario Public Roads and Highways Commission, Chairman; A. R. Hirst, State Highway Engineer of Wisconsin; A. N. Johnson, Highway Engineer, Bureau of Municipal Research, New York, N. Y.; E. L. Powers, Editor, "Good Roads," and Dr. Joseph Hyde Pratt, State Geologist of North Carolina.]

PRESIDENT McLEAN: You have heard the report.

MR. DEAN: I move the report be accepted and the recommendations adopted.

MAJ. CROSBY: I second the motion.

PRESIDENT McLEAN: You have heard the motion, gentlemen. All in favor of the motion say aye. Opposed, no. The motion is carried.

The next item on the program is the report of the Committee on Resolutions. The Secretary will please read the report.

[Secretary Powers then read the report of the Committee on Resolutions.]

PRESIDENT McLEAN: You have heard the report. What is your pleasure?

[After some discussion regarding the exact wording of the resolutions and a slight amendment thereof, the following resolutions were adopted:]

Report of the Committee on Resolutions

RESOLVED, That the A. R. B. A. expresses its appreciation of the cordial welcome extended to it by His Excellency, the Governor of the State of Illinois; His Honor, the Mayor of Chicago, and the Association of Commerce of the City of Chicago—a welcome, the sincerity of which has been evidenced by the many courtesies we have received at their hands.

RESOLVED, That the A. R. B. A. extends its sincere thanks to the state, county and city officials, the commercial organizations of the city, the Western Society of Civil Engineers and the different organizations which are devoting their attention to road improvement, for the many courtesies extended by them, all of which have contributed so conspicuously to the enjoyment and profit of those in attendance at this convention.

RESOLVED, That the A. R. B. A. expresses its keen appreciation of the kindness of the Saddle and Sirloin Club in extending to us the courtesies of its club and the use of its rooms during the convention.

RESOLVED, That the A. R. B. A. hereby expresses its appreciation of the valuable cooperation of the manufacturers, states, cities, colleges and all others who have, by their excellent exhibits and efforts, contributed so greatly to the value and instructiveness of this convention.

RESOLVED, That the A. R. B. A. extends its hearty congratulations to the State of Illinois, Cook County, and the City of

Chicago upon the great popular interest which is being shown by the public in the subject of road improvement, and upon the substantial progress which is being made in that direction; and that the Association wishes them abundant success in the wise planning and efficient execution of these improvements.

[The Committee on Resolutions consisted of Nelson P. Lewis, Chief Engineer of the Board of Estimate and Apportionment of New York City, Chairman; Paul D. Sargent, Chief Engineer, Maine State Highway Commission; Major W. W. Crosby, Consulting Engineer, Baltimore, Md.; A. W. Dean, Chief Engineer, Massachusetts State Highway Commission; A. R. Hirst, State Highway Engineer of Wisconsin; Dr. Joseph Hyde Pratt, State Geologist of North Carolina; T. H. MacDonald, State Highway Engineer of Iowa; James H. MacDonald, formerly State Highway Commissioner of Connecticut, and S. D. Foster, Chief Engineer, Pennsylvania State Highway Department.]

Friday, December 18

SIXTH SESSION, 10:30 A. M.

CHAIRMAN MEEKER: Gentlemen, if you will come up toward the front we will make an announcement out of the regular line of business. As you know, yesterday a tentative invitation was sent to the members of this convention to visit the Stock Yards and the members were further informed that guides would be furnished to take them through the Stock Yards. Mr. J. R. Hills is here representing the Stock Yards Association and also Swift & Co. He will now give you this invitation in detail and tell you what to do and where to go and what there is for you to see. (Applause.)

[Note: At this point Mr. Hills extended to the convention an invitation to inspect the plant of Swift & Co.]

CHAIRMAN MEEKER: Now, gentlemen, you have heard the invitation of Mr. Hills and I will leave it to the members individually to decide what they want. You may form little parties of your own to go down there, or, if you simply wish to go singly or by twos Mr. Hills will be around here. You can decide among yourselves what you want to do about visiting this great industry that has made Chicago famous.

The first paper this morning on "Recent Practice in Construction in Wood and Granite Block" is by William A. Howell, Engineer of Streets, Newark, N. J. Mr. Howell is not present and therefore I will call on Mr. R. H. Gillespie, Chief Engineer of Sewers and Highways, Borough of the Bronx, New York, N. Y., to read the paper.

Recent Practice in Construction in Wood and Granite Block

By WILLIAM A. HOWELL
Engineer of Streets and Highways, Newark, N. J.

Wood Block

That the neglect to pave properly the main street of a city affects to a degree an entire nation in the course of a year came to be realized by the City of Newark in November, 1912. The occasion was the annual football game between Yale and Princeton, at Princeton. The occupants of probably 3,000 automobiles from all parts of New England, from Canada, from New York State, from as far west as Chicago, passed over Broad street, Newark, and commented bitterly on the condition of the street. They could not realize how a city of the size of Newark could tolerate such a pavement.

In 1884, Broad street was paved with a new granite pavement on a sand foundation. This pavement gave general satisfaction until about ten years ago. The increased use of the automobile, and the desire of department store owners and various large business concerns for a smooth pavement started the agitation for a new pavement, which was not realized until 1914. One reason for delay was that in Newark the bulk of the cost of all paving improvements has to come out of the pockets of the property owners on the street to be improved. This is true not only of the first paving, but also of the second, third or even fourth. The city has grown so rapidly, that it has not been able to secure adequate legislation at Trenton, to properly apportion the cost of improvements of main arteries on the city at large, as is done in many large cities. Another cause for delay in the repaving of Broad street was the bitter contest between the Mayor and the Board of Public Works over the selection of the proper paving material to be used on the street, the Mayor waging persistent warfare in behalf of granite block, and the members of the Board of Public Works equally as determined in their advocacy of wood.

Broad street is to Newark, what Broadway is to Manhattan; it is Newark's most important street. Two railroad stations, a dozen banks, two of the largest insurance companies in the country, the City Hall, the Public Library and the postoffice are all located on this street. Agitation had become so strong for a new pavement that as far back as 1910 provision had been made for the installation of electric light and telephone conduits, new high pressure water mains, new gas mains, and new water, gas and sewer lateral house connections. Excavations necessary for the

installation of these various pipes and conduits left the pavement in a very rough condition, as, anticipating that a new pavement would soon be laid, the temporary repaving following the various excavations was poorly done. The result was that Broad street was probably the poorest paved main street in the United States in November, 1912, when the thousands of automobiles passed through the city on their way to Princeton. Even after the award of the wood block contract but before any actual work had been done under that contract, a visiting delegation from Atlantic City, who were inspecting city streets, rode over the street and came to the conclusion that Newark was twenty years behind the times with such a pavement on its principal street. The public press while advising caution in the selection of the right kind of pavement, urged the authorities to action.

The members of the City Plan Commission in 1913 deemed it their duty to recommend a suitable pavement to the Mayor who appointed them. After careful investigation and taking numerous traffic records, Messrs. George B. Ford and E. P. Goodrich, Consulting Engineers to the Commission, presented their summary, and recommendations, to the City Plan Commission as follows:

"Asphalt pavement should be eliminated from consideration, because, despite its lower cost, the expense of maintenance makes its ultimate cost as much, or larger, than either granite or wood block. Furthermore, the constant repair demanded by asphalt means that the streets are always being torn up, with the consequent incommoding of the traffic. Wood block and granite are so nearly alike in first cost and in maintenance cost, that this item may be eliminated from consideration. Granite block is a little less slippery, and a little longer wearing, and a little easier to repair, and a little easier to superintend and inspect. Its tractive value is slightly less than wood block. It is more dusty and much more noisy. The comparative advantages of the two are nearly equal, but we recommend wood block for Broad street, because of the recent experience in Manhattan and other cities of the country, which has shown a rapidly growing tendency to make quietness the first consideration in determining the type of pavement. We realize that the rapidly growing use of rubber tires tends to swing the balance in favor of granite block and that twenty or twenty-five years from now, when the question of repaving of Broad street will probably come up again, the almost universal use of rubber tires or something similar will cause the abandonment of wood block in favor of stone block or

some similar development, but we believe that present conditions demand the use of wood block."

The newly organized Board of Public Works of 1913 composed of five commissioners took up vigorously the matter of paving the street from Belleville Avenue to Poinier Street, a distance of approximately 12,200 ft., calling for an area of 88,500 sq. yds. independent of the portion to be paved by the street railway company where new granite blocks were to be used. The proposed improvement was divided into four sections for convenience, and contracts were tentatively awarded July 31, 1913, for 4-in. wood block on an 8-in. concrete foundation, the blocks to be treated with 20 lbs. of oil per cu. ft.

The Mayor vetoed this award August 14, 1913. His veto was sustained by the Board of Public Works on September 4, 1913, it requiring four votes to pass a measure over the Mayor's veto and only three votes being forthcoming, one commissioner, although personally favoring wood block, deferring to the wishes of the property owners on the lower end of the street, many of whom were opposed to any kind of new pavement. Proceedings were promptly started all over again, the lower section of the street was eliminated from consideration, and new bids were received on October 30, 1913, for 75,500 sq. yds. of 4-in. wood block with 18 lbs. of treatment, the concrete foundation to be 8 ins. in thickness. This contract was finally awarded about February 1, 1914. The average price per square yard of the low bidder on the four sections had been $3.67 and the figure of the low bidder at the second letting was $3.34 per sq. yd. The total amount of the successful bidder's contract was close to $300,000. As under existing laws, 70 per cent. of the cost of local improvements is assessed directly on the property owners benefitted, but 30 per cent. of the total cost being assumed by the city at large, in the case of Broad Street the property owners fronting on the new pavement will have to pay $14, $15 and $16 per front foot according to the width of the roadway in front of their property.

The pavement, completed October 1, 1914, is practically 10,000 ft. long or about 1.9 miles. For nearly one mile of this distance the street is 132 ft. wide between building lines, the width of the roadway is 92 ft. between curbs and the space between the street railway and the curb is about 38½ ft. on each side of the street. The grades on Broad street are remarkably flat. On 20 per cent. of the total area paved, the prevailing grades are less than 3 ins. per

100 ft.; on 50 per cent. the grades range between 3 and 6 ins. per 100 ft.; on 20 per cent. additional the curb grades are between 6 and 12 ins. per 100 ft.; and on but 10 per cent. of the pavement are the curb grades in excess of one per cent., the steepest grade on the newly paved portion being slightly over 2 per cent. for a few hundred feet only. The specifications were prepared by Mr. Morris R. Sherrerd, Chief Engineer of the Board of Public Works, after a most painstaking and exhaustive study of the subject and after holding consultations with most of the leading wood block experts in the eastern portion of the United States. The Board of Public Works accompanied by the Chief Engineer inspected wood block pavements in a number of cities. The following extracts from the specifications may prove of interest:

The blocks shall be treated with the preservative, so that the charge for each batch of blocks shall contain an average of 18 lbs. per cu. ft. The specific gravity shall not be less than 1.07 nor more than 1.12 at a temperature of 38° C. The blocks comprising each charge shall be selected, as nearly as may be, so that all of the blocks placed in the cylinders will be of the same degree of seasoning.

The new blocks shall be laid on a mortar bed composed as follows: A layer of sand and cement 1 in. in thickness, mixed dry in the proportion of one part Portland cement to four parts of sand shall be spread on the concrete foundation, and struck to a surface parallel to the grade and contour of the finished pavement. The cushion of sand and cement, unless previously moistened, shall be lightly sprinkled with water, and the blocks shall be immediately set thereon.

The blocks shall be from 5 to 10 ins. long, but shall average 8 ins.; they shall be from 3 to 4 ins. in width, and they shall be 4 ins. in depth. The blocks, however, shall be of uniform width for each city block, and there shall always be a difference between the width and depth of the blocks of not less than ¼ in.

(Note: This last provision was inserted to facilitate the laying of the blocks with the head up.)

The blocks shall be thoroughly wet by immersion in suitable tubs, or tanks of water, just before being laid, care being taken to prevent the water from becoming a nuisance, or doing any damage to the work.

This method of thoroughly soaking the blocks for ten minutes before laying them in the pavement is new to this country and has been criticized on account of the expense involved in maintaining so large a number of tubs and the men necessary to handle them properly. The results so far obtained seem to justify the method and it will undoubtedly be a feature of any future wood block contracts entered into by the City of Newark.

Of the total area laid, about 40,000 sq. yds. were shipped

in schooners from Mobile, Ala., from the works of the Republic Creosoting Co. These blocks were nearly 4 ins. wide and 4 ins. deep, running about 38 to the yard. The remaining 35,000 sq. yds. were manufactured and treated in Newark at the local works of the American Creosoting Co. These blocks were 3 ins. wide and 4 ins. deep, and ran about 55 to the square yard. Mr. R. Ernest Beaty, Assoc. M. Am. Soc. C. E., inspected the manufacture and treatment of the blocks at both plants. An interesting statement from Mr. Beaty is appended. This work was prosecuted with great vigor, and finished in advance of the allotted time. There were lawsuits instituted threatening to stop the work but fortunately they were of no avail.

A very interesting feature connected with the paving of the street was the installation of a large number of traffic platforms at important street railway transfer points. These platforms were built of concrete. They averaged in length about 85 ft. They were all 6 ft. wide, located 2 ft. outside of the rail, and averaged 6 ins. in height above the pavement. The steps of the local street railway cars are rather high, and these platforms at once became popular with many thousands of people. As the roadway on the greater part of the street is 38½ ft. between the rail and curb, the installation of these platforms did not interfere with the free movement of traffic except in possibly two instances.

Mr. Sherrerd's specifications provided for expansion as follows:

1. By providing for expansion joints along the curbs, 1½ ins. wide, to be filled with a suitable bituminous filler capable of passing a good penetration test.

2. By laying the blocks comparatively loosely in the pavement, in order not to have any tight joints, sand being carefully broomed into the joints.

3. By soaking all of the blocks in 40 or 50 half barrels used as tubs, in which the blocks were required to be submerged in water for ten minutes before laying.

The only trouble occurring on the street of any moment was along the street railway tracks, in spots where the rail moved. Even if the movement was slight, it would gradually raise a few blocks and the sand would run down under the block, causing the block to be higher than the rail. This happened in less than a dozen spots in 10,000 ft. of pavement. The street railway people made the necessary repairs to their tracks in these spots, and the contractor relaid the block, using cement in the joints for a space of about one

foot from the rail. Some of this action of the movement of the rails was due to the uneven wear of the head of the rail, producing a hammer effect. These inequalities in the rails have been ground out, and this action helped in preventing a movement of the rail.

The Engineering Department also made, in its judgment, ample provision for drainage by building a large number of additional side sewer basins, and rebuilding nearly all of the old basins on the entire length of the new pavement, so that at the present time there is a good, serviceable basin every 200 ft. on either side of the street. As low crowns are especially desirable on wood block pavements, the street railway tracks were lowered as much as possible, and the old gutter depths of 7, 8 and 9 ins. on the old granite pavement were reduced to 5½ and 5 ins. on the wood block pavement.

The bleeding was extremely noticeable on several warm days when the thermometer ranged from 90° to 97° in the shade and possible 115° to 120° on the pavement, but by causing the blocks to be covered with a thin coating of sand, no unpleasant conditions followed. During the summer and fall the pavement was sprinkled quite frequently. Early in the fall a thick coating or crust formed on top of the blocks, caused by the oozing out of the preservative and its coming in contact with sand. The contractor scraped this off and removed it from the street on several occasions. This coating did not stick to shoe leather to any appreciable extent, and did not produce any unfavorable comment from storekeepers in regard to being tracked into buildings and soiling the floors, as was the case with the wood block pavement on Market Street, Philadelphia, a few years ago. In an editorial a short time ago, on slippery conditions existing on a number of heavy traffic streets in the center of the city, one of the leading local papers remarked that horses seemed to have less trouble getting a foothold on the Broad Street wood block pavement than they had on the various asphalt and bitulithic streets in the same locality. Whether that statement would hold good throughout the winter is problematical.

The Yale-Princeton football game occurred on November 14, this year, and thousands of automobiles passed through the city as was the case two years ago, but their occupants found a different main highway pavement from the one they encountered in 1912; and the change met universal approval.

Referring to the inspection of the blocks at the two plants,

Mr. R. Ernest Beaty makes the following comments in a note to the writer:

"The above contract, as is generally known, calls for approximately 75,500 sq. yds. of pavement. Of this yardage about one-half is of 4x4x8-in. blocks, while the remainder is of 3x4x8-in. blocks. The 4x4-in. blocks were manufactured by one company, while the 3x4-in were manufactured by another. Each order was supplied from a very good quality of southern long leaf yellow pine, and the various charges making up the two orders were very carefully inspected and manufactured. Tests made for 'drying out and absorption' did not demonstrate any marked superiority of one order of blocks over the other. This is hardly to have been expected, as apart from variation (within limits) of specifications of oil used, tests previously made show that the smaller blocks (3x4-in.) are practically as waterproof under the customary test for absorption, i. e., 24 hours in an oven at 100° F. followed by immersion in water for 24 hours, as are the longer or 4x4-in. blocks. The principal point of interest to be noted in connection with this contract lies in the difference in chemical constituents of the two preservatives used in treating the two orders. Attached is chart showing analysis of twelve samples of oil. Of these samples six were taken from oil used on the Mobile blocks and six samples were taken from oil used on the other blocks. The oil specifications for this work were as follows":

The preservative to be used shall be a product of coal tar, which shall be free from oil adulterations, and contain no raw or unfiltered tars, petroleum compounds, or tar products, obtained from any process other than stated.

The specific gravity shall not be less than one and seven hundredths (1.07) nor more than one and twelve hundredths (1.12) at a temperature of thirty-eight (38) degrees Centigrade.

Not more than three and one-half (3½) per cent. shall be insoluble by continuous hot extraction with benzole and chloroform.

On distillation which shall be made exactly as described in Bulletin No. 65 of the American Railway Engineering and Maintenance of Way Association, the distillate based on water free oil, shall not exceed one-half (½) of one per cent. at one hundred and fifty (150) degrees Centigrade, and shall not be less than thirty (30) nor more than fifty-five (55) per cent. at three hundred and fifteen (315) degrees Centigrade.

The oil shall not contain more than three per cent. of water.

It is to be noted from this chart that, while within limits of specifications, there is quite a dissimilarity in the two groups of samples. The specific gravity of the oils; the specific gravity of the fraction between 235° C. and 315° C., and the insoluble matter in oils of the two groups, vary some-

what; but the marked difference lies in the fraction between 210° and 235° C.

It is, of course, unwise to attempt to classify certain definite compounds; however, we may say that the fraction between 210° and 235° C. is ordinarily considered commercially as being "napthalene" with a certain portion of allied constituents. In one case, it is seen, that one of the oils (considered as a group) contains fully four times as much of the napthalene compounds as the other. Also, that this oil contains correspondingly a lesser amount of higher boiling fractions, such as anthracene, etc., than the group with which it is compared.

It has been demonstrated time and again by evaporation tests from flat dishes that some of the lower boiling distillates of creosote oil are exceedingly volatile when compared with the higher boiling fractions. For this and other reasons, many chemists are opposed to allowing more than a minimum amount of this fraction to be present in oil used for treating paving blocks.

On the other hand this fraction is considered very valuable in an oil for treating piling work, and one of our large public service corporations requires 20 or 25 per cent. of it in an oil used in treating exposed timbers, and for conduit purposes. One advantage it possesses is the comparative ease with which it penetrates the blocks. However, equally satisfactory results were secured with both oils. This point alone cannot be relied upon for oil containing the greater amount of the fraction under discussion, or against the oil containing the lesser amount.

Many theories do not work out in practice, and the opponents or advocates of either side of the controversy will find in service conditions on Broad Street a practical argument bearing on the matter. Inasmuch as both orders received the same careful inspection when manufactured, were laid under identical inspection in the street and by the same contractor, engineers of the department interested in wood block pavement should note with interest comparative results regarding "bleeding" and "buckling" of pavement in the respective areas paved with the 4x4-in. and the 3x4-in. blocks.

Granite Block

That a smooth, durable, close jointed, grouted granite highway, passing through the center of large towns or acting as a connecting link between two neighboring towns, is desirable

for all kinds of traffic, and especially so for heavy traffic, is conceded by all well informed road builders. This form of pavement, introduced originally in Worcester, Mass., and made popular about five years ago through the efforts of Chief Engineer Morris R. Sherrerd of the Board of Public

OIL USED IN TREATING 40,000 SQ. YDS. OF 4"X4"X8" WOOD PAVING BLOCKS FOR BROAD ST., NEWARK, N. J., DURING THE YEAR 1914.

Sample	% To 200° C.	% 200°-210° C.	% 210°-235° C.	% Total to 235° C.	% 235°-315° C.	% Total to 315° C.	% Sp. Gr. of Oil	% Sp. Gr. of Fraction*	% Water.	% Insoluble Matter.
1......	0.0	0.0	2.08	2.08	33.70	35.8	1.113	1.05	0.0	0.8
2......	0.0	0.0	2.10	2.1	33.70	35.8	1.113	1.05	0.0	0.8
3......	0.2	0.35	5.95	6.50	38.60	45.1	1.085	1.05	0.0	1.1
4......	0.0	0.65	3.70	4.35	33.45	37.8	1.115	1.05	0.0	2.3
5......	0.0	0.50	4.27	4.77	35.65	40.3	1.108	1.05	0.0	1.0
6......	0.0	1.00	5.40	6.40	30.75	37.2	1.095	1.06	0.0	2.3
Av'ge..	0.03	0.4	3.9	4.4	34.30	36.7	1.103	1.05	0.0	1.38

OIL USED IN TREATING 37,000 SQ. YDS. OF 3"X4"X8" WOOD PAVING BLOCKS FOR BROAD ST., NEWARK, N. J., DURING THE YEAR 1914.

	%	%	%	%	%	%	%	%	%	%
7.....	1.80	3.2	15.2	20.2	22.7	42.9	1.117	1.04	1.0	2.0
8.....	0.50	1.4	20.5	22.4	26.2	48.6	1.100	1.04	0.5	1.4
9.....	0.50	2.8	18.3	21.6	24.1	45.7	1.109	1.04	3.0	1.7
10.....	0.50	1.5	19.5	21.5	22.8	44.3	1.10	1.04	0.0	1.6
11.....	0.50	2.0	14.0	16.5	24.0	40.5	1.11	1.04	0.5	1.7
12.....	0.70	2.8	18.9	22.4	27.2	49.6	1.09	1.04	1.7	1.9
Av'ge..	0.70	2.3	17.7	20.7	24.5	45.2	1.101	1.04	1.1	1.7

*Sp. Gr. fraction between 235° and 315° C. at 38° C.

Works of Newark, N. J., has established itself in a large number of important cities east of the Mississippi River.

Mr. Sherrerd was the pioneer in the establishment of the present close-jointed granite block, having recommended a paving block that could be laid with a ⅜-in. joint as far back as 1908. This width of joint is included in the specifications for granite block pavements in one of the boroughs of Greater New York, but the majority of cities using this form of pavement have accepted the specifications of the Society for Standardizing Paving Specifications (merged in 1913 with the American Society of Municipal Improvements) in which the width of joint is ½ in. Under Mr. Sherrerd, the ⅜-in. joint was given a thorough trial, with both fine grained and coarse grained granite blocks, and it was found to be practically impossible to carry into effect with coarse grained granites.

There was a popular fallacy years ago that granite was granite; in other words, that granite pavements did not have to be as carefully inspected during their construction as brick or asphalt pavements as the granite material was supposed to be absolutely uniform and homogeneous throughout the entire shipment. Municipal engineers frequently come across soft places in granite pavements, where the pavement is wearing much more rapidly than at other points, although the traffic is the same throughout the entire length of the pavement. This condition may arise on account of veins of soft or foreign material in the granite quarry or it may have been caused through the deliberate shipment of defective material, known to be defective when originally shipped.

Basing his opinion on situations similar to the above enumerated, the writer has come to the conclusion within recent years, that it is almost as necessary to have frequent tests of granite blocks, as it is to have car-load tests of paving brick shipments. The necessity for the adoption of some simple and comparatively inexpensive test to speedily determine the quality of granite block shipments becomes more and more apparent to thoughtful men interested in paving. The old method of crushing granite cubes has practically been abandoned. Personally the writer hopes to soon see a method introduced similar to the standard abrasion test for vitrified paving bricks. In order to carry out that idea properly, all blocks tested would have to be cut to a uniform size and be made from the same material.

At present the most reliable test for toughness is made on the Page impact machine, and fairly satisfactory results are being obtained through this method. On the recommendation of the Sub-Committee on Standard Specifications on Stone Block Paving of the American Society of Municipal Improvements, the minimum figure for toughness was placed at 11 in the 1913 convention of that society. In 1914 at the Boston Convention the impact figure was changed to 9. The necessity for a rigid adherence to this test has been demonstrated on several occasions, lately coming within the notice of the writer.

A very heavy traffic street, in a large city, carrying two street railway tracks, on a very narrow roadway was paved with granite known to be especially desirable and suitable for its grouting qualities. The distance from the outer rail to the curb was only 10½ ft. Granite blocks from the same quarries had previously been used on other heavy traffic streets but where the traffic was not concentrated over such a narrow space. The pavement almost immediately after receiving

traffic began to show decided signs of wear, much of the wear appearing on a line parallel with the track and about over the outside edges of the ties of the street railway tracks. The grouting did not last more than a few days within a space of about two feet outside of the rail. The explanation given by the granite people was that the frequent passing of heavily loaded trolley cars and motor trucks caused frequent vibration of ties and a consequent jarring of the granite paving, causing the newly grouted granite blocks to rock and never permitting the cement grout to have a chance to set and consequently the grouting in this 2-ft. space was worthless. The constant rocking of the blocks produced abrasion to such an extent that within a week or ten days a small hole appeared in the pavement. Within two months these holes became exceedingly numerous. The situation was still further aggravated by the passage of heavy motor trucks overlapping the new pavement, it not being possible to block off the newly paved roadway for its entire length in order to afford clearance for the overhang of the trolley cars. Tests were made of some of the blocks taken from the pavement and also of new blocks taken from the same quarries. The highest figure given in any of the impact tests was 8 and in several instances the figure fell to 4. On the other hand with granite blocks submitted as samples from a well known Southern quarry noted as producing a very hard granite, the impact figure was 13. This granite was not very susceptible to cement grout.

The inference from these results is plain. On heavy traffic granite streets where the traffic cannot be shut off sufficiently long through the grouting and cement setting period, and on granite streets where the impact tests show a figure as high as 13, cement grout should not be used at all, but tar and gravel filler should be substituted.

Newark has laid since 1900, 18 miles of close-jointed grouted granite pavements, including many miles in factory districts, in hilly sections and on main arteries connecting Newark with such important suburban towns as Elizabeth, East Orange, Bloomfield, Irvington and East Newark.

Napped, reclipped, grouted granite pavements have also been introduced in Newark by Mr. Sherrerd. This form of pavement was first laid in Bronx Borough in 1909. The idea originated in the fertile brain of Mr. William Booth who was not only the owner of granite quarries but also a paving contractor. This form of granite pavement has become exceedingly popular in the vicinity of New York City and such cities as Troy, Albany, Schenectady, Philadelphia, New-

ark, and the Boroughs of Brooklyn, Manhattan and the Bronx. All have mileages of napped reclipped granite pavements. In Newark, Broad Street was paved with wood block, the pavement being completed about October 1, 1914. The yardage was about 75,000 sq. yds. The old granite blocks, about 75 per cent. of which were in fairly good condition, were carted away and sold to contractors at $30 per thousand. The contractors halved them, reclipped and redressed them and used them for paving a number of other streets. In one section of the city there were three hill streets paved with new granite blocks and three other streets paved with the napped blocks, and in some instances the napped block pavement produced a smoother surface than the new block pavements. The specifications for this form of block are very similar in many towns, although in some cities instead of halving the blocks, they are cut into three and four fragments, depending on the length of the block.

In Bronx Borough the average cost for 267,150 sq. yds. was $1.68 per sq. yd. including a 5-in. concrete foundation, up to November, 1913, for recut, old granite block compared with an average of about $3.67 per sq. yd. for new granite block on the same foundation. The blocks were split, broken in two and dressed so as to lay ½-in. joints. The finished blocks are from 6½ to 8 ins. long, 3½ to 4½ ins. wide and 5½ to 6½ ins. deep. Blocks less than 11 ins. long are reheaded, when necessary, and dressed, and as a rule used along railway tracks. The splitting and dressing is done on the streets by stone cutters who receive about 1½ cts. per redressed block, or $15 per thousand; each man getting out from 450 to 500 blocks per 8-hour day. He earns from $6.75 to $7.75 per day, depending partly on his skill and speed and partly on the character of the granite and condition of the old blocks. The blocks when dressed are piled along the sidewalk until the concrete foundation is ready for the pavement.

Newark awarded contracts for nearly 40,000 yds. of this form of pavement, in all but one contract the blocks to be furnished the contractor at the City Yard, the contractor to have the blocks napped and reclipped before hauling to the improvement. The competition was so keen and the successful bidder was so low in his figure that he could not afford to pay reasonable rates to the stone cutters, and frequent strikes and labor troubles resulted. The city is seriously considering the project of employing expert stone cutters to nap and reclip many thousands of blocks, under city supervision, and then sell the completed blocks to the

contractor. In this way better results could be obtained. As to the financial saving effected by the use of recut and napped or redressed blocks in Newark, with prevailing prices, the assessment on the property owners on a 36-ft. street, using new granite and new curb would be about $8 per ft. or $200 for a 25-ft. lot. If napped and reclipped old blocks were used (the old blocks being sold to the contractor by the city) probable cost per foot of assessment to the property owner would be $6.35 per front ft. or $158.75 per 25-ft. lot, with old blocks obtained from other streets.

But if the old paving blocks on the street are taken up, napped and redressed and used in repaving that pavement, a still greater saving can be effected; so that the estimated cost per foot front would be $4.75, or $120 per 25-ft. lot. A granite pavement which has given twenty-five or thirty years' service, may give an additional service of twenty-five years under the methods described in the latter portion of this paper.

CHAIRMAN MEEKER: Gentlemen, I am sure we are very much obliged to Mr. Gillespie for reading Mr. Howell's paper. The discussion will now be opened by an engineer who has probably had a wider experience in municipal work than any one present. He has been the City Engineer of Omaha and at present is the Consulting Engineer of the Borough of Brooklyn, Mr. George W. Tillson. (Applause.)

GEORGE W. TILLSON (Consulting Engineer to the Borough President, Brooklyn, N. Y.): Mr. Chairman and Gentlemen: This subject is so large that in saying what little I shall say I will try and state the standard practice of engineers without discussion and then discuss to some extent the matters which are unsettled in the general practice.

The wood used for wood pavement in this country is almost entirely Southern yellow pine. It would be extremely desirable to get other kinds of wood that would give satisfactory results, so that the demands upon one particular kind would not unduly increase the price. The size of the blocks does not seem to change very much and to be very material except in depth. The practice is from 3½ to 4 ins. in depth. Less than 3½ ins., where, perhaps, the wear might allow it to be used, is not desirable on account of the liability of the blocks to split and that is particularly true of all hard pine. The width of the blocks generally varies from 3 to 4 ins., no matter what the depth. It is, as was stated in the paper that has just been read, undesirable to have the depth and

width the same, because if they are the pavers invariably will lay some of the blocks flat and in a very short time the wear is very great on these blocks and causes holes. The most important part, probably, of wood block pavement, is the treatment of the blocks and there is considerable discussion and considerable uncertainty at the present time as to the best form, both as regards treatment itself and character of the preservative. Now, one thing to be desired in a wood paving block is to get one that will be stable. By that I mean one that will not expand in wet weather or contract too much in dry weather. The other thing is to treat the block so that it will not decay. That is, you want a block that will not rot and you want one that will not swell in wet weather. Now, both of these results can be obtained to a certain degree by the treatment.

Wood has been treated in different ways for a great many years and there have been many kinds of treatments but when expense and everything is taken into consideration, the general feeling among engineers is that creosote oil is the best preservative. This oil is, as you all know, volatile to a certain extent and for that reason, as stable an oil should be used as possible. In the early days the only creosote oil used was made from coal tar. Since the manufacture of water gas, the water gas people have produced a certain amount of creosote oil and the question is whether the water gas tar oil or the coal gas tar oil should be used, or both. The English engineers in their report to the Third International Road Congress that was held in London in 1913, said that it should be a product of coal gas and the practice in Europe generally is for coal tar, and that is true at the same time in this country. Now, whether the water gas tar oil is good or not, we do not know, or as good as the coal tar, but we ought to know and there should be some experiments made to determine whether this oil is as good as the other. If it is, we want to use it. If it is not, we want to know it so as to make no mistake in using it.

The aim of every engineer should be, first, to get good results, second to get them as cheaply as possible and if the water gas tar oil can be produced more cheaply than the coal gas tar and give as good results it should be used without any restriction whatever. It has always seemed to me that the government, with its machinery for making tests, is the proper party to make a test of this oil. While it takes so very long to make a test in actual practice on the street, it does seem that by some accelerated test, the government

could ascertain the relative merits of the two and give to the public something that would be authentic and a report which no one could assail as being controlled in any way by private interests.

Another thing in connection with the oil is its specific gravity, whether it should be a light or a heavy oil. That is a question. A good many people think that the lighter the gravity of the oil the better, because it will penetrate the block more uniformly than the heavy oil and will produce just as good results as far as the preserving of the wood is concerned. Other people are in favor of the heavy oil because they think and in fact are satisfied, that it is less volatile, that it will penetrate the block sufficiently to preserve it and keep it from bulging, and for that reason it would preserve the block longer than the lighter oil. Now, the preserving of the wood block is particularly important in this country because, as a rule, our traffic is not sufficient to wear out the blocks.

A year ago this winter the Forest Products Association had an exhibit in the Grand Central Palace in New York and they showed there an example of wood block pavement that had been taken from a street in Brooklyn that had considerable travel. The pavement had been down 10 years. Those blocks showed a wear of ¼ in. so that if wear only was concerned, that pavement would last 40 years and the only suffer a wear of 1 in., leaving 3 ins.

In the old country, where the traffic is heavy, it doesn't make so much difference whether the blocks are treated so thoroughly, because they wear out on many of these streets before they would rot out, especially in London where the climate is damp, and where the blocks do not get as thoroughly dry as they do here. The question of bulging or the liability of bulging is not as great as it is in this country where we have so many months without any rain at all.

One of the defects of wood pavement and one which it seems to me is very great and which we should work to overcome if possible, is its slipperiness. In New York, what you people know as New York, and what we call there the Borough of Manhattan, many of the streets off lower Broadway, running from Broadway down to the North River, are paved with wood. Those streets have a slight grade, and in that climate it is too steep for our hardwoods because they are used all the time by heavy traffic and are slippery and have given considerable trouble. Of course, this slipperiness can be obviated in such places by sprink-

ling with sand and that should be done where the blocks have been laid on such streets.

Another device for reducing the slipperiness is what you may have noticed on our boulevard or street in the arena of the Amphitheater where there are lugs on the ends and on the sides of the block, the idea being that if the blocks expand that expansion will be taken up by compressing the blocks together and compressing these lugs rather than bulging the pavement.

I want to say something about the quantity of the preservative to be placed in blocks, on this question of bulging. When we first made specifications for this character of wood in New York City we provided that the blocks should receive 20 lbs. per cu. ft. of treatment. Then it was a question how we would find out whether it had the 20 lbs. or not, because then nothing was known about the method of treatment or how to make the tests. It was decided that if we made an absorption test of wood blocks, something in the way that the absorption test is given to the bricks for brick pavement, that we could determine fairly well whether the blocks had been sufficiently treated in order to produce good results in the pavement. So while we provided for the 20 lbs. of treatment and did not provide any special test to ascertain whether the 20 lbs. had been put in or not, we did specify that the blocks after having been dried in an oven at a temperature of 100° for 24 hours should not absorb more than 3 per cent. of water when dried and immersed in water for another 24 hours. We got good results in that way and while, in some cases, there was some trouble in obtaining blocks with that absorption, still they were obtained and the results have been such that in New York City, the only place I think where they use this test, the absorption test, we lay the pavements without any expansion joint whatever and have had practically no trouble from bulging where the blocks stood that absorption test. There were one or two cases in Manhattan and one in Brooklyn where the blocks were laid under a private contract and not tested by the city, where there was some bulging, but, as a rule, wherever the blocks sustain that test of 3—and later we raised it to 3½ per cent.—we have had absolutely no trouble from bulging. But you must be sure to get the 3½ per cent. absorption. In that way you know the blocks have received a good treatment. Another test in that early pavement was that the blocks should sink in water. That was another indication of the amount of treatment that the blocks had received because the specific gravity of dry hard

pine is such that if it will sink in water you know that it must have had pretty nearly 20 lbs. of treatment.

Now, in stone blocks there has been considerable change in the work during the last four or five years. The present form, the oblong granite block, was the evolution of the old large rough stone block that was used for so many years when stone pavements first came to be used in the old country and which you see so very plainly in pictures published in the many magazines of the streets of Pompeii where excavations have been made during the last 20 to 25 years. Some of the stones are as large as this table and show from the construction that they had no vehicular travel at that time, as Pompeii was destroyed, you will remember, in the first century of the Christian era and no wheel vehicles were used in Europe to any extent until the 16th or 17th century. All these blocks were simply used as pavements to cover up the surface of the earth street. The oblong form of block was first used in the late '60s and early '70s in this country and then ran from 12 to 14 ins. in length and from 8 to 9 ins. in depth and 3½ to 4½ ins. in width. Those blocks were laid for many years on a sand foundation. I think it was in 1871 that the first concrete foundation was used in this country and that was when a pier in New York City was paved by the Dock Department with granite on a concrete foundation. The object of having the blocks so deep, that is, 7 to 8 ins. in depth and allowing that inch in variation, was because they were to be bedded in sand and so it was thought that that inequality would not make any difference. The great cost of granite block is the cost of cutting and the nearer you make the block conform to a perfect size the more expensive it is. After the use of granite pavement on concrete, and not for a long time after, it was decided to reduce the blocks in size and also to have them made better in form so that we would get better and smaller joints. With these old blocks you would have a joint that, while it was supposed to be only 1 in. and then filled with tar and gravel in many cases it would be 1½ ins. That would allow the edges of the blocks to round off and where the traffic was heavy in five or six years you would find the block round on top instead of flat. That not only made the block itself rough and uneven but it made it wear very much more rapidly because there is nothing which conduces to the length of the wear of the pavement so much as to have it perfectly smooth on top so that the traffic and the weight come vertically on it. The minute you tip up a block so that wheels

strike the edge you get undue wear. This is true of any block pavement.

About five years ago the engineers of New York and some of the neighboring towns got together with the contractors to find out how good a stone block could be made at a reasonable price. An engineer, if he wants to do anything, can sit down and write specifications for any kind of a job that he wants, but there is no use for him to write specifications for material or for the work to be done in a certain way if he cannot get this material and in order to do the work in the way he wants it done, it is going to cost so much more that it makes it prohibitive. After some discussion at this meeting it was decided to change the size of the blocks a great deal, making them only 6 ins. in depth and having them cut so that we could get a ⅜-in. joint. The contractors thought they could do that without much trouble. They found it, however, more difficult in practice than they thought, although the result has been that in New York and vicinity, the granite pavements have been very much improved during the last three or four years and we hope in the near future to see them improved just as much more. As was intimated in one of the papers, I think it was yesterday, possibly this morning, the introduction of the rubber tire is going to make granite much more popular as a paving material because it can be laid smoothly and with the rubber tire the great objection to it, that is its noise, is overcome. The old pavements of granite or the improved pavements had joints, as I said, from 1 in. to 1½ ins. in width. Many of them were filled with gravel and then the interstices of gravel filled with a composition of coal tar pitch and asphalt, the proportion being about 20 lbs. of asphalt to 100 lbs. of pitch. My idea has always been that if we could get a pitch sufficiently tough, we should lay the granite blocks close together (if we laid them close together when they were put in the street, the rolling or ramming would make a certain joint) and then fill the joints with pitch only. Now, a great deal of the noise caused on the granite pavement is that when a wheel strikes a block the noise is carried from one block to another and the sound accumulates making the rumbling roar which you would not get if you only had the results of the pounding upon an individual block. Now, if we can get a filler, a joint filler, that will take up to a certain extent that noise, will be resilient and a non-conductor, the noise will be reduced very much and so make the pavement much more desirable. So, if you can get a granite pavement laid with a smooth surface and with a joint filler that does not

transmit sound readily, you will reduce very much the objections to the granite pavement on heavy traffic and wholesale business streets.

Another way of producing a filler that would give good results, I think, is the practice that has come into use more in England than in this country, although it has been tried recently to a certain extent in Manhattan in New York—that is by mixing sand with the pitch to make it tougher. That I think will give good results and it can be poured in a very little joint. Of course, if you have a narrow joint and put sand or gravel in it first, and then try to fill the interstices with pitch, these interstices are so small that the pitch will not flow through them freely and a water tight joint is not obtained.

CHAIRMAN MEEKER: I am sure we have all profited very much by Mr. Tillson's discussion of this matter, and I will now call on Mr. E. R. Dutton, the Assistant Engineer of Minneapolis, to continue the discussion.

E. R. DUTTON (Assistant City Engineer, Minneapolis, Minn.): Mr. Chairman and Gentlemen: I have not any very extensive discussion on this matter and I will only take up one feature of the wood block, that is, its slipperiness.

In the most excellent presentation of the paper on the construction of creosoted wood block pavement on Broad Street in Newark, N. J., the author has gone into the details of such work and made a comparison of creosoted wood block pavement with other smooth top pavements. One particular comparison was made as to its slipperiness, which he found to be "less than on asphalt or bitulithic pavements in the same locality" but upon grades none of which exceeded 2 per cent.

It would be well, therefore, in the disucussion of the subject "Recent practice in construction in wood and granite block" to consider what has been done and what is being done to make the creosoted wood block paving better—and to decrease or remove any difficulty or objection which may exist in its use for paving purposes. There have been so few objections, and so many advantages, that its use has grown very rapidly in the past few years. The principal objection raised to its use is slipperiness. This same objection applies equally as well to any smooth top paving, and if it is to be prevented, it will be by abrasion or by roughness.

The ordinary rectangular creosoted wood block can be safely used on grades up to 3 or 4 per cent., if made of

southern yellow pine, and up to 5 or 6 per cent. if made from a softer wood such as Norway pine. We have used in the City of Minneapolis, Norway pine blocks on the latter grades without experiencing any difficulties, but we find that the wear on a Norway pine block is about twice what it is on a southern yellow pine block.

There are several patented blocks on the market, one of which, and perhaps the best, is one having lugs about ½ in. in height formed on the sides of the blocks, thereby separating them when laid and allowing a larger joint to be filled with the bituminous material. There have been many different methods of construction used in various places to obviate the objection. In some places a sprinkling of sand on the surface of the pavement is used as a temporary relief and answers its purpose as long as the sand remains. A little advancement on this method is the use of stone chips which are spread over the surface of the pavement and held in place by some bituminous material coated over the top of the blocks. These are only surface treatments and will have to be renewed at more or less frequent intervals.

There are other methods, however, that enter into the original construction of the pavement and are more or less permanent in character. One of these I noticed was where every other row of block was laid about ½ in. below the adjacent blocks. This was a very poor construction, though it accomplished the purpose for which it was evidently intended, and overcame the slipperiness by introducing the element of roughness with a vengeance and made a high-priced corduroy road out of material that should have produced a smooth and pleasing surface.

Another method is one in which one of the upper corners lengthwise of the block is chamfered about ½ in. in depth by about ¾ in. taken off the top surface of the block. These are laid in contact the same as ordinary blocks, with the chamfered corner on the down-hill side of the block. This method has been very satisfactory and does not detract materially from the smoothness of the pavement, and does not add very much to the cost.

Another, and perhaps later method, has been introduced and used where the rows of blocks are separated about ½ in. This separation of the blocks is accomplished by using strips of wood between the courses or rows. This was used in the old creosote paving, laid in Galveston, many years ago. The separation of the blocks, however, was not made necessary on account of the grades, as you might say there were no grades, the land being almost level. The present

method of construction for such work, is to use a creosoted filler or separating strip ½ in. thick by 1½ ins. in width. One of these strips is placed between the rows of blocks and resting upon the cushion, thereby leaving an open space between the blocks ½ in. in width and 2 or 2½ ins. in depth from the top, depending upon the depth of the block. After the blocks are laid in this manner they are rolled as usual and the joints are filled full with a crushed stone ⅓ to ⅛ in. in size. The whole surface of the pavement, the voids in the stone and the joints between the blocks, are then filled and coated with a medium soft coal tar. Heated stone chips are then spread over the surface and are held in place by the tar. These stone chips will naturally wear off in time, but the stone and tar in the joints will remain and accomplish the desired results.

CHAIRMAN MEEKER: The next speaker comes from a city that was one of the pioneers in wood block laying, St. Louis. Is Mr. Hempelmann here?

The next gentleman to take up the discussion will be Mr. Maetzel, the City Engineer of Columbus, Ohio. Mr. Maetzel is not here.

Is Mr. H. W. Durham, Chief Engineer of Highways of Manhattan, present?

H. W. DURHAM (Chief Engineer of Highways, Borough of Manhattan, New York, N. Y.): Mr. Chairman and Gentlemen, I am very sorry that these other gentlemen who were to continue the discussion of this paper are not here, for I feel that I am probably the one least qualified to add anything to what has already been said and what would have been said by them. Perhaps I can amplify or suggest a few things in reference to the New York practice, which Mr. Tillson did not touch on in the somewhat full treatment of his subject.

First, if I may be pardoned, I would like—if it isn't aside from the subject, as both these types of pavement we are talking about, granite and wood, in the minds of almost every one, require a foundation—to correct a misconstruction that was put on some remarks of mine day before yesterday in regard to the necessity of foundation which I stated was more or less a matter for local consideration; by that I meant local physical consideration, not political (laughter) as was suggested by some one commenting on my statement. The successful construction of stone block pavements,

has been carried on abroad without foundation, but I think that under the conditions prevailing in our country no one would advocate at the present time that a good stone block pavement should be laid without an adequate foundation.

In the last few years in the City of New York, initiated during the time when Mr. Tillson had control of the paving in Manhattan and since carried on in Brooklyn and Manhattan, and in the other boroughs of the city likewise, we have made the improvements in our specifications already mentioned. There is one point that I would like to bring out in addition: The question is very frequently discussed as to the necessity of special qualities in the stone that is used in our granite pavements, as to what tests should be made on them and as to whether certain granites are not better than others. It is also a subject of considerable discussion, whether it is preferable to use a bituminous or a cement grout filler, and a great deal of positive assertion has been made in favor of both of those methods. My experience in the Borough of Manhattan is that it is very much more important to see that your blocks are accurately dressed and laid on a minimum thickness of cushion with closest possible joints, virtually in contact, having flat heads to produce a smooth surface, than it is to say that the rock from this or that or the other quarry is better, and that the products of certain quarries not passing our certain ideal specifications cannot be received. In a granite pavement we are not using a manufactured product, but something made by nature. Making certain tests of little cubes of granite from certain quarries and saying they have particular qualities does not change the nature of the material or the possible sources of supply that we have to depend on. Any granite that we get is very much harder and more durable than any other class of material; and we find in our Manhattan practice, that by stating in our specifications that the contractor shall name the source of his supply, and then, having examined the general output of the principal quarries on which we can depend, and insisting very rigidly on requirements of minimum variation in the head of the blocks and accurate cutting of their size, and by requiring that they shall be laid in virtual contact so that there is no need of any gravel filler or anything else to hold them in place before or after completion, we get a pavement that is absolutely satisfactory whether the block comes from one of the quarries producing a fairly soft granite or is some of the hardest material. I can point to streets where the blocks are laid

with stones from both sources of supply and where after two or three years it is impossible to note any difference in the appearance of the head of the block, entirely due to the fact that the joints are so close that there has been no opportunity for wearing round on the edges, which is the principal source of deterioration in the stone pavements.

There is one other statement I wish to make in regard to the question of tests. It was urged that we require minimum specifications to be fulfilled by our blocks very much in line with those determined by the United States Bureau of Roads for macadam material. On making tests from all the quarries from which we hope to receive materials for our pavements at an economical price, I found that if we insisted on the rigid figures certain of our critics asked for, we would have to rule out about 90 per cent. of the quarries available, practically reducing the available source of supply to one or two quarries and not even being assured that all the material from those quarries would pass specifications. In making some remarks on that line to one of the critics who made the suggestions with regard to these specifications, I was told that there must be something very wrong in these tests we had made, that they probably had been made on old-fashioned testing machines, because the latest improved machines gave very much higher results, showing an utter misapprehension on his part of the purpose of tests. If you improve your machine, you don't change your source of supply which has been in existence since the world was made. You can't go and call for certain types of material as you would if you were buying steel.

On the other question of joint filler, that is an open subject and one to be determined by local conditions as to whether we should have bituminous or cement grout filler. There can be cited instances of successful pavements of both types. It has been stated by some of our universally-knowing critics that cement grout filler is never used in European cities. As a matter of fact, it is, but not to as large an extent as bituminous filler. I have seen in a German city a very successful pavement laid, where a cement grout filler was used by filling the joints with sand and cement mixture, and pouring water up to a depth about 2 ins. from the top, and then pouring tar on top of that, making a mixture of the two. It looked perfectly ridiculous, but it made a beautiful pavement. In the conditions prevailing in our city, New York, the first consideration, and one Mr. Tillson referred to, is the question of noise, and that is very largely

determinative in the selection of bituminous filler, because there are so many office buildings along our heavy traffic streets that a very noisy pavement would be absolutely ruled out. The other is the necessity we have for making frequent openings in the streets. I think it is almost impossible to make frequent openings in pavements which have been constructed with a cement grout filler and restore them to their original condition, certainly it is much more difficult than to do it with the bituminous filler we use, because it is necessary to keep the traffic off for a period of several days to allow the filler to set, and we desire to turn traffic on within a few hours after replacing. I have even been told it should be done over night. We have the greatest success in our pavements by using a coal tar filler, previously mixed with the greatest amount of fine sand that it will take up and yet retaining a consistency suitable for pouring. We have not been able to use at the present time over one-third in volume. In the City of Liverpool they use as high as 50 per cent., due to the fact that they have very fine sand there, and we expect to study the question with a view to increasing our requirements as to the quality of sand and see if we can't save the bituminous material at the expense of sand.

But we are every year improving the quality of our stone pavements so that motor traffic, and particularly rubber-tired motor traffic, finds it practically as smooth as the wood and asphalt pavements, and the noise from steel-bound wheels and horses' hoofs is not 50 per cent. of what it was on the old type rough cobbles or rounded head Belgian block. On the question of wood pavements there is little I can add to what has already been said. The present tendency in our city is to approximate more nearly the London practice of laying the blocks on a hard instead of an elastic cushion, with the use of a bituminous instead of a sand or a cement grout filler. Abroad the pavements of wood block are almost invariably laid on a smooth concrete foundation, either finished by screeding or by subsequent floating. They do not, however, lay their concrete as rapidly as we do. On the Strand a year ago, I watched paving, where the work was going on at about the rate of 100 sq. yds. a day. In our practice in New York, one gang has done almost ten times that amount, on many of our streets five times. They very frequently keep that rate in the laying of the foundation, and we could not spare the time to lay concrete by hand mixing and with the careful smoothing of the surface that they do abroad. It seems to me that it will be possible,

however, with better organization of our machine-mixing gangs to work between forms set to an accurate surface and with a screed or templet formed to the correct profile of the street drawn over the concrete after it has been deposited, to produce a surface that will be accurate enough to lay the blocks directly on. At the present time we are not attempting that, but are spreading a mortar cushion composed of cement and sand dampened, and laying the blocks on that. We think it the best practice to lay the blocks slightly loose, filling the joints with bituminous filler to give some room for expansion. We have slightly modified our absorption requirement, that is in Manhattan, not in Brooklyn, allowing a maximum absorption of 5 per cent., but are not fully decided as to whether it is desirable to take up the expansion joint question again. Mr. Tillson feels very strongly that it is unnecessary. I agree with him in regard to our heaviest traffic streets, but on some of those where the traffic is not so heavy it seems to me it will be better to allow for some expansion and not try to prevent it by an excessive amount of oil, which, in the extremely hot weather, bleeds and is carried away on the tires of the vehicles, hoofs of horses and feet of the pedestrians, to the great annoyance of the general public. The final question in regard to the satisfactoriness of a wood pavement surface to my mind is thorough cleaning. I think that unless the Street Cleaning Department, whether it be under the jurisdiction of the Bureau of Engineering or Department of Highways, or however it may be organized, performs its duty thoroughly on a wood pavement, that pavement is less satisfactory than any other type; while that class may have the best surface in the world, it requires more attention than almost any other. A dirty granite pavement is unpleasant but it does not impede horse or motor traffic. A dirty asphalt pavement is slippery in wet weather and a dirty wood pavement is more slippery in wet weather and frosty weather. A wood pavement in order to prevent any formation of a thin skin of dirt, which forms a thin liquid grout in wet weather, must be cleaned often and that is absolutely necessary to prevent the skidding of motor vehicles. It is a curious fact that in New York we say wood pavements are not successful on grades equaling or exceeding 3 per cent., yet they are satisfactory abroad—not only the softer woods but some of the harder woods—up to grades of 5 per cent., and the City of Berlin only uses wood blocks on grades, preferring asphalt in all other cases on level surface. Thank you gentlemen. (Applause.)

CHAIRMAN MEEKER: This is a very interesting subject and has been presented to you in a most edifying manner and I would be very glad to throw this question open for discussion. But as the hour is getting late and many of the members wish to visit the Stock Yards we will defer any open discussion of this matter and take up the next subject, "Present Practice in Earth and Gravel Road Construction and Maintenance." This paper will be presented by Professor Ira O. Baker, of the University of Illinois, who is known to every road engineer, if not personally, at least through his works. Professor Baker. (Applause.)

Present Practice in Earth and Gravel Road Construction and Maintenance

By IRA O. BAKER
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Somewhat early in arranging the program for this meeting I was invited to open the discussion of a paper upon earth and gravel road construction; but shortly before the assembly of this convention I was begged to prepare the leading paper upon this topic. After having promised to prepare this paper, I was in great doubt as to the manner of treatment that should be adopted.

In many of our states are highway departments that are doing much valuable work in building state aid roads and in studying the problems concerning road improvement; and the men connected with these organizations need no instruction as to the methods to be pursued in constructing or improving earth and gravel roads. Unfortunately, most of the several state highway departments have little or nothing to do with either the construction or the maintenance of earth and gravel roads, since as a rule their chief function, if not their sole function, is to construct permanent hard roads and safe bridges on the main lines of travel; and consequently the improvement and maintenance of the plebeian earth and gravel roads, particularly the former, is left mainly, if not wholly, to the local authorities. As a result, the earth or gravel roads are not constructed as well as they easily could be, nor are they cared for as well as should reasonably be expected.

This condition has led some to conclude that it is not worth while to attempt to improve an earth road; and that the only thing that can be done is to do every thing possible to secure a hard surface for all the roads possible. Of course, this is a very superficial view; and of course it is

impossible to construct a hard surface on more than a small per cent. of the earth roads. In most states to secure a permanent hard surface on even the main roads will require several years. In most localities, at least 90 to 95 per cent. of the highways have only an earth surface; and under even the most enlightened system of state aid road improvement, at least three quarters of the wagon roads for many years to come will have no better surface than can be made of the native surface soil.

Because of their great preponderance, and because of their importance in the industrial and social development of rural communities, earth roads are entitled to much more consideration than they have yet received at the hands of either engineers or local road authorities.

In view of this fact, it may be worth while to briefly consider wherein lies the importance of earth roads, and then what can be done to improve them.

Importance of Earth Roads

Earth roads are important to the financial, social, and educational development of the rural community. The earth roads are the real highways of commerce; and without them there would be but little, if any, use for macadam roads or roads having a better surface. Not much need be said here about the financial advantages of improved earth roads because they are comparatively slight, except in certain restricted areas and for certain relatively unimportant branches of agricultural operations.

It is utterly impossible to justify any general improvement of earth roads upon financial grounds alone. The farmer knows what it costs him to market his products, and the average or representative farmer (note the limitation) is sure that no road improvement will materially increase his annual profits. Of course, in the long run the easier of access the market is to the farmer, the lower will be our cost of living; and hence the city dweller is interested in the quality of the roads from the farm to the railroad station. But it will not be profitable to discuss this phase of road improvement further here.

The social effects of the roads of a rural community are in the long run more important than the financial effects. The earth roads are the channels through which the farmer has social intercourse with his rural neighbors and with his friends in the village and nearby towns; and without reasonable facilities for such intercourse this country can not hope to keep upon the farm the brightest and most ambitious of the rural population, either young or old.

Owing to the rapidly increasing population of this country and the practical exhaustion of unoccupied farming land, unless our agricultural operations are more efficient in the future than in the past, an increasing number of people in this country must before long go hungry; and hence every citizen should be intensely interested in maintaining the rural community at its highest efficiency. One way of assisting in securing this desirable end is to give the best possible roads to the farmers.

Closely related to the social advantages of good roads is the effect of improved highways upon the intellectual development of the rural community. The roads from the farm to the village are important factors in the education of the farmer, since good roads permit the consolidation of rural schools or make it possible for the country boy or girl to participate in the larger benefits of the village school. The vital importance to every inhabitant of the establishment and maintenance in this country of a system of both productive and permanent agriculture demands that the social and educational value of earth roads shall have adequate consideration.

Further, an improvement of the earth roads will aid in the industrial development of the rural community and consequently add to the ability and willingness of the farmer to vote additional sums for the improvement of the main roads as well as for the improvement of the local roads.

There is still another aspect in which the roads of a rural community are worthy of more consideration by those who seek to improve the main lines of travel. In nearly all states the farm property pays a very large proportion of the public taxes. Any one who has not investigated this matter will probably be greatly surprised at the proportion of taxes paid by the farming interests. Of course, the proportion of the taxes paid by rural communities will vary with the relative number of cities in the state. In Illinois outside of the county in which Chicago is situated, the farming property in 1912 paid 76.6 per cent. of the taxes. This proportion varied from 36 to 95 per cent. in the different counties. In view of this fact, it would seem to be wise for those who are advocating a system of state aid for road improvement, to give more consideration to the truly rural roads. In most states no far-reaching system of road improvement can be adopted against the wishes of the rural community; and if the farmers feel that their interests are having adequate consideration, they are more willing to accede to the expenditure of considerable sums in improving the main roads.

It is not overlooked that in some states having large cities within their borders, a considerable part of the state taxes are paid by the cities and that consequently in those states the relative importance of the contribution of the rural communities for road improvements is not as great as in the states not having a great metropolis within their borders. Further, the fact is not overlooked that in many states a considerable part of the money spent for road improvements is collected by license fees for automobiles. On the other hand, it should not be forgotten that the number of automobiles owned in the rural communities is rapidly increasing; and as the number owned in the country increases, the rural interest in improved roads will increase in a greater ratio. Of course, a considerable part of the state aid for the improvement of the main roads comes from the state treasury; but the interests chiefly to be benefited by the improvement of earth roads pay a considerable part of the taxes from which that fund is drawn; and further in nearly all plans of state aid for road improvement, the local community pays from one to two dollars for each one from state funds, and hence the agricultural interests usually pay a very large proportion of the contribution for state aid roads. Another important advantage of improving the earth roads is that as the system of state aid roads is extended, the principal earth roads will be given a hard surface and the ordinary methods of improving these roads are the very best preparation for the hard road surface. From the preceding, it is apparent that there are several important reasons for giving consideration to the proper construction and maintenance of earth roads. It remains then to inquire what can be done to stimulate interest and advancement in this branch of road work.

Drainage

One of the most important features of an earth road is its proper drainage. It is important that all having to do with either the construction or maintenance of earth roads should be impressed with the great value of thorough drainage. The three distinct forms of drainage should be carefully distinguished, viz., underdrainage, drainage by side ditches, and surface drainage by maintaining a smooth and properly crowned surface. The reason for each of these particular forms of drainage and the methods to be employed to secure each should be thoroughly understood by all having to do with the construction and maintenance of earth roads. The principles involved have been so frequently stated and are so easily found in road literature, as to make it unwise to consider them further here.

Maintenance of Earth Roads

The importance of proper maintenance for hard roads has usually been under-estimated by engineers; and hence it is not surprising that the importance of the maintenance of earth roads has been under-estimated by laymen. Now that engineers are coming to appreciate better the importance of maintenance for hard roads, it is hoped that these professional men will assist in creating a proper public sentiment in rural communities in favor of a better maintenance of earth roads. Apparently, editors of engineering journals, particularly those making a specialty of highway work, could be of material benefit by calling attention to the importance of such work and perhaps also by publishing articles suitable for reproduction in the agricultural press.

The difficulties to be overcome in securing any material improvement in the maintenance of rural highways are as much political as technical. The local highway commissioners are elected by their fellow citizens, and the selection depends often as much upon political methods as upon ability, and is often the result of an inefficient man seeking the office for the emoluments rather than because of the possibility of public service. For these and other reasons, the tenure of office is short, and consequently the community is unable to get the fullest benefit from the experience of its road officials.

Again, the administrative unit for rural road work is exceedingly small, and consequently the official duties are but an incident in the life of the official; and since he usually has little or no supervision, the very natural result is that he postpones his official duties until a favorable opportunity in his private life.

It would undoubtedly be of advantage to the roads if the administrative unit were larger; but the securing of this change is likely to depend upon the vote of the local community, and the electorate is reluctant to relinquish what it calls self-government. For example, the new road law which recently went into effect in Illinois, provides that towns may vote as to whether or not they will continue under the present method of three highway commissioners or adopt the plan requiring only one highway commissioner. In the greater majority of cases that have come to the knowledge of the writer, the people have voted to continue the three commissioner plan. In other words, they have elected to continue with the smaller administrative unit. It is desirable that those who favor the larger administrative unit should not fail to present their views as opportunity offers,

in order that public sentiment may be educated to a more efficient system of road administration.

It is agreed that in many of the states, particularly the older settled ones, the intellectual ability and resourcefulness of the rural community has been decreasing for many years past, owing partly to industrial evolution, and partly to the increase of the non-resident ownership of the land. Therefore, it is the duty of the patriotic citizen to do all within his power to improve the intellectual and social conditions of rural life.

One way in which this improvement may be secured is to teach the rural road officer a more effective system of organization and a more efficient method of performing the duties at present allotted to him.

The general introduction of automobiles has made necessary in the last decade a complete revision of the methods of hard road construction, and has also made it easier to secure improvements in road legislation and to secure larger sums for highway improvements. Therefore, now is an opportune time to see if improvements cannot be made in the maintenance of earth roads.

Road Dragging

One of the most important things in the maintenance of an earth road is that it shall be dragged whenever the surface becomes roughened through travel while muddy. There are but few rural communities that appreciate at its full worth the importance of the dragging of the earth roads; and those who seek the benefits of road improvement can probably not do better than to aid in creating a healthy public sentiment in favor of this method of road work.

Not only is it desirable that public sentiment shall be created in favor of this form of improvement, but in most rural communities it is necessary to develop a thoroughly efficient and economical system of doing this work. More will be said of road dragging presently.

State Highway Commissions and Earth Roads

In some of the states, particularly those in the Mississippi Valley, the state highway commissions are rendering valuable aid in the improvement of earth roads. These commissions prepare addresses and issue bulletins on road subjects, and some of them have officials who give at least a part of their time to the earth roads. Of these commissions, perhaps that of Iowa is doing more for earth roads than that of any other state. The work of the Iowa commission as affecting earth roads will be briefly considered.

Earth Roads in Iowa

The Iowa State Highway Commission has jurisdiction over all the roads and road officials of the state. It has adopted standard cross sections for these roads, has established limiting grades, made rules for breaking long grades, and has made recommendations concerning alignment at railroad crossings and on curves. These rules and regulations have been printed in bulletins which have been widely distributed, and are having an important influence upon the improvement of earth roads in that state. It would be beyond the scope of this paper to attempt to reproduce in detail any of these rules and regulations.

One of the most important features of the Iowa road law and of the work of the Iowa State Highway Commission is the provision made for dragging the earth roads. The law provides for a township superintendent who has charge of all of the road dragging and repair work of the township road system. He makes contracts for dragging the roads, and sees that the work is properly and promptly done. The men who drag the roads are paid from a fund raised especially for that purpose, and which can be used for no other purpose. In 1913 the fund for dragging was $750,000, which is an average of $7.32 per mile. The township superintendent certifies to the correctness of all bills for dragging and for maintenance and repairs, which bills are itemized as to time, place and amount of work done; and without this certification no money can be drawn from the treasury. The pay of the township superintendent does not come from the fund for dragging, and all equipment is paid for from funds other than those provided for dragging of roads. The township superintendent makes contracts with local residents or others for dragging the roads whenever necessary and whenever directed by the superintendent. The price paid is 35 cts. per mile traveled. The contract specifies the form of drag, and the method of using it; and further specifies that the men doing the dragging shall remove all loose stones or sticks from the traveled portions of the highway, and that they shall carry shovels and make any small repairs at culverts and bridges that may be required, and also remove all bumps or accumulations from the road surface. These men are also required to remove any accumulations of grass, weeds, brush, etc., from the culverts and bridges. The contract contains an agreed penalty for the failure to drag the road when needed or when directed. The road official whose duty it is to see that the roads are dragged at the proper time is liable to the law whether the neglect be his

own or of others upon whom he has placed the responsibility. This feature of the law has recently been tested in the courts and has been upheld. In the test case the four councilmen of a town were indicted for neglect of duty in failing to drag the roads as provided by law; and upon trial they were found guilty and fined $5 each. For the second offense they are liable to a fine of $500 and a year in the county jail, or both.

Some of the other prairie states could profitably follow Iowa in the provisions for dragging their earth roads.

The New Illinois Road Law

The State of Illinois on July 1, 1913, put into operation a new road law which is very excellently conceived, and which promises to produce marked improvements in the roads of the state. The one feature especially worthy of consideration in this connection is the provision for a county superintendent of highways who has authority over the roads of the county, other than the state aid roads. These officers secure their appointment by the county boards only after having been nominated to the State Highway Commission and having passed an examination under the direction of that commission. The examination to which the candidates for this office were subjected was quite elementary, but was probably as severe as was wise for the introduction of the new law. Even though the examination was very elementary, a very considerable number of candidates were unable to pass; but on the other hand, a number of the candidates apparently could have passed a much more severe examination. At least, some of those who did pass are men of considerable engineering experience.

These county superintendents of highways have been in office only one working season, and it is altogether too soon to determine the full possibilities of the office. Further, practically none of these officials had given any considerable attention to the construction or maintenance of earth roads; and probably none of them had ever considered their official relationship to the local highway authorities. Still further, it is very natural that the local highway officials, having been shorn of part of their authority, should be somewhat jealous of the new county superintendents. Still again, it is not possible through an examination certainly to secure on the part of the county superintendents of highways that degree of tact and managerial ability required for the best results in the supervision of local highway work by the new county officials. Finally, many of these superintendents receive such small pay as not to secure the best men, nor perhaps the most efficient results from the present appointees.

Nevertheless, notwithstanding the difficulties and limitations, the plan is working reasonably well, and gives promise of material improvement in the local highways.

Presumably, in accordance with the requirements of the law, all of these officials have inspected all of the roads and bridges at least once during the year. Several of these county superintendents have called the local road authorities together to consider methods of highway construction, maintenance, and administration. At these meetings the county superintendents have not only sought to instruct the local road officials in road matters, but have tried to instill into them high ideals of public service. Further, many of these county superintendents by the use of the local press have sought to stimulate a greater public interest in road improvements in general, and particularly in the improvement of earth roads. The method and spirit of many of these county superintendents is illustrated by the following paragraph from the instructions published by one of them in the official paper, "Illinois Highways," which has been largely reprinted.

"In the spring, as soon as the ground has settled sufficiently to get on them with a tractor, clean out the side ditches, using a 6 or 8-ft. grader and going two or three rounds, as may be necessary. Then follow up with the leveler, pulling the loose dirt into the hollow places and giving the road the proper crown. When this is done, I believe the heavy machinery should be put in a shed and left there. Road drags, under ordinary weather conditions, if timely used will keep the roads in good shape until winter, and even in winter the drags can be used to advantage. In getting the drags used systematically will be the hardest part of the work. The commissioners should make arrangements with farmers along a certain road to drag at the same time when called up by the commissioner or by some one appointed to do so. Of course, the entire length of the road in the township should be dragged; for if parts of it are not, then some of the benefits of the dragging that is done will be lost. The work should be done after rains. If the road is not badly rutted, the dragging need not be done until the ground is partially dried out; but if the surface is uneven, the work should be done while the ground is still wet so as to fill up the hollow places. Some neighborhoods will not take hold of the work at first; but I believe that when they see what is accomplished in other places, they will gradually fall into line. Each man doing dragging should be provided with blanks to be filled in and mailed to the commissioner immediately after doing the work. These

slips should state the time, section of road, price per mile, and the amount due for dragging on that date."

Wisconsin Road Law

The State of Wisconsin has a comparatively new road law which provides for a county highway commissioner having much the same authority and duties as the Illinois county superintendent of highways, and he probably finds somewhat the same difficulties and limitations as his Illinois brother official. The ordinary soil and the climatic conditions in Wisconsin are more favorable for earth roads than in either Iowa or Illinois, and are less representative of the states in the Mississippi Valley, and hence nothing will be said about Wisconsin earth roads. However, Wisconsin fortunately has considerable quantities of gravel suitable for use in roads, and the commission of that state is doing very commendable work in developing a system of scientific gravel road construction which is probably the best of any in this country.

Good Roads Day

The holding of a good roads day in which rural and urban citizens shall join in the construction or improvement of a piece of the public highway is a means of not only securing a piece of improved road, but the observance of such a day can be used to stimulate interest in road work and also to secure a more cordial understanding between the inhabitants of the country and the city. It would not be difficult to offer objections as to the possible efficiency of a good roads day as a means of constructing or improving roads; but such an occasion can be fully justified, provided considerable attention is given to arousing more interest in the roads, and to an interchange of views on highway problems between the different classes of people who use the roads. The experience in some such attempts has been that there was a surprising readiness to cooperate in such public improvements. In not a few instances city chambers of commerce and city automobile clubs have made very substantial contributions for the improvement of the earth roads leading to the cities in which these organizations had their headquarters.

Conclusions

The earth roads are important channels for the commerce of the country, are large factors in the social and church life of rural communities, and are of vital importance to the present rural educational interests and the future industrial developments of agriculture. The very life, credit and prosperity of our country require that the rural community shall have the highest possible development, and the quality of

the road from the farm to the village and the town may aid or retard this development. On one hand, the earth roads should not be improved at such expense that the cost will be a real burden upon the community; and on the other hand the roads must not be so poor as to be a bar to the highest reasonable development of the community. In nearly every case the earth roads can be greatly improved without appreciable expense, and with much advantage to the local community and to the entire country.

CHAIRMAN MEEKER: Gentlemen, I know you have all appreciated very much Prof. Baker's paper and I hope that those in the country districts will pay particular attention to what he said and take the good words of advice home with them and apply them to their roads. The discussion on this paper will now be taken up by Mr. James A. French, State Engineer of New Mexico. Is Mr. French in the room? Evidently not.

Then you will have the pleasure of listening to Mr. Fred E. Ellis, Manager of the Essex Trap Rock & Construction Company, Peabody, Massachusetts, who is a man who builds roads and knows how they should be built. (Applause.)

MR. ELLIS: I think I misunderstood, Mr. Chairman and gentlemen, what was really meant by the title of this paper of Prof. Baker's and as I had no copy of it before it was delivered and I heard it here today, I probably cannot discuss it as freely as I would like.

PROF. BAKER: You are fortunate then. You have got the whole world before you.

MR. ELLIS: I was in hopes it would have more to do with the construction of roads than it did have. I only want to say a few words about the practice we are up against on the construction of gravel and earth roads. I don't think there is any more difficult problem that the contractor has to deal with than the earth and gravel roads. In the first place, the people who are paying for the roads, and new engineers, as a general thing, think that an earth road or a gravel road can be built to be as hard and compact and give all the year round service, the same as a macadam road or a bituminous road. That is especially true in communities where the road proposition is new. They don't seem to realize that the earth road or gravel road, especially where the climate is such that the roads are affected by frost and heavy rains, is not going to be in good condition all the year round. There are going to be some times during the year when that road will be an uncomfortable road to ride on.

Of course, a road built in the summer may look all right, but when it comes to frost, people who are paying the money for that type of road will think it is altogether the fault of the contractor if the surface rolls up on the wheels and the road gets rutty and muddy.

I attended a meeting in Boston about a month ago and some of the state highway commissioners from other states were complimenting the State Highway Engineer of New Hampshire upon about 20 miles of good gravel road that had been constructed in that state. Now, as a matter of fact, it was not a gravel road at all, that is, the surface material on that road would not come under any specifications for gravel which I ever saw. There are a good many stones in the locality and the road was graded and in many places it was practically paved with cobbles. Gravel was not to be had in that locality. The surface was of sand and hardpan, what we call hardpan down there; you might call it clay with a little stone mixed with it. Either one of the substances would not make a road if used separately. The whole secret of that road was the foundation. If the surface had been placed on loam or the drainage hadn't been taken care of, I don't think they would have had such good results. If the road was not in the country district where there was no objection to having open ditches 3 ft. deep at the side of the roads, they would not be so inclined to compliment it, but those ditches kept all the ground water out and that together with a stone foundation under it made the road a very good road in the summer. It is on the east trunk line to the White Mountains. It gets very heavy traffic in the summer and practically no travel during the seasons when the frost is coming out or going into the ground. This road has never been oiled, unless it was oiled late this last season. Some of the earth roads and gravel roads in New Hampshire have been oiled and the commissioner says that once the oil has been put on, it interferes very materially with the maintenance. It is more expensive to maintain the road. The addition of a little of this hardpan and sand or local material and the use of a road drag will keep the road built up all the time, whereas, if oil is put on the road the drag will not smooth out the ruts, and new material will not stay on the road. I think the construction of an earth or gravel road simply means that it is going to be the foundation some time or other for a coming top.

PROF. BAKER: Some of it, anyway.

MR. ELLIS: The crown on the grades should be more than it is on the flat, so that the water won't run lengthways

of the rut but will run off out of the road at the side. I don't think there is anything more discouraging to the contractor than to try to build a good gravel road. I think the difficulty lies in the specifications for gravel. Most of the specifications that I have seen, and of course my remarks can only apply to that portion of the country that I have had experience in, and that is New England and New York State, provide that the gravel shall be practically free from clay or loam. Now, as a general thing we can find gravel practically free from clay or loam, but we can't build a road out of it, because although there may be some fine particles of sand in the gravel there is really nothing to bind the road unless you grind the gravel up. If it is a soft clay subgrade or a sandy subgrade or a subgrade that lets the water run away from it, it is impossible to grind the gravel up to make enough fine stuff to bind the road, that is to flush it out the same as you would flush out a macadam road. At some time or other during the construction, often after the waste of a lot of time and money rolling and watering, the addition of some such material as clay or loam is made. All that expense might have been saved if it had been put in before rolling. Very often, I might say almost every gravel road that I have worked upon, and that has been quite a number, we have started off with the idea that the gravel must be free from clay or loam and it has always ended up by the addition of some such material as clay or loam for use in binding it. It is not very satisfactory to put that material on after the road has been rolled because it only goes two or three inches into the road and it simply makes a crust. When the dry season comes the crust breaks and forms pockets and rough places. I think if some such man as Prof. Baker said in a loud tone of voice or had it in his paper that clay or sandy loam mixed with the gravel was not detrimental but gave good service it would be very kind of him and save a lot of trouble to the contractor, and give the community better gravel roads.

I have never seen any gravel that made a good road unless it contained some loam or some such substance as clay; that is the physical properties of the fine material resembled clay. I wouldn't say the chemical constituents are just the same as clay, but the action as far as road building purposes are concerned was just the same as when clay was used. I thank you. (Applause.)

CHAIRMAN MEEKER: Gentlemen, I want to add a few words to what Mr. Ellis has said in reference to clay in gravel. In the southern part of New Jersey we have sev-

eral hundred miles of very fine gravel roads and most of that gravel contains not less than 10 per cent. of clay. In fact, it is impossible to build a good road of clean or washed gravel. You will get something to keep you out of the mud, but you will slip and slide around and the road is very hard on horses and the tractive force required is very great, while on a clay and gravel road for eight or nine months in the year you have one of the smoothest and hardest and most convenient roads for travel that it is possible for man to build.

The next gentleman on this program to take up the discussion is Mr. W. S. Gearhart, State Engineer of Kansas. Is Mr. Gearhart present? Evidently not.

Is Mr. Archibald McGillivray, Provincial Commissioner of Highways, Winnipeg, Canada, present? He is not.

Mr. John A. Gaffey, general contractor, Medford, Mass., was to take up this discussion and I have a note from him saying that he has asked Mr. James H. McDonald, former Highway Commissioner of Connecticut, to take up the time allotted to him. Is Commissioner McDonald in the room? If so, we would be very glad to hear from him. Evidently not.

MR. EZRA STOLTZFUS: May I have a few minutes to make a few remarks on earth road construction?

CHAIRMAN MEEKER: Certainly.

MR. STOLTZFUS: I am a good roads advocate and I came here for the cause, and to learn and to take home a thought which may finally develop in results in our own neighborhood, and I feel also that possibly by the interchange of thought we can help the cause along all around. I want to take but very little time because the time is very short on this question. First, we must know the economic, fundamental, practical principles to be put in practice, considering the conditions. We see that the earth road problem is not so very enticing. I came here not that I had any wares to sell, or that I expected to get anything out of it, but I came here to learn, and to carry home the thought, and spread the gospel of the earth road. The few remarks I would like to make are on the articles in the paper. The farmer is the one that pays the most tax. We also learn that the rural earth roads are the beginning of the arteries to the cities, and to the railroads, as has been brought out in the paper; that the rural roads and earth roads are the feeders to the main arteries. Therefore, gentlemen, it seems to me without making any imposition on any one, that the earth road is entitled to and should be given more thought

than it is. There is possibly a reason for that, and one reason may be that of the material man and the machinery man, who are more directly interested in their line of road building, not having any reflection whatever, because it is all necessary. But there should be more of an agitation for good earth roads. We also heard a remark in a paper here that we need the visionary man. I can say I am one of the visionary men. I have been giving the earth road problem thought since I have been in business for myself, starting in 1892 or 1893. I have had a great many occasions, being a lumber man, to use the roads in all kinds of conditions, and generally on a wet day I was out on the roads looking after the other end of the business. The great problem is the water drainage, and how to overcome it. The thought that has finally developed in my mind is to make that earth road surface waterproof. The thought that I have in view is to work in harmony with nature in the way of studying soils and closing the pores. I think there is a possibility there, if the thought of man is directed that way. It may seem far away to a great many men here because I will admit with you that the thought that has generally grown up in our minds since we were boys going to school, was that to get out of the mud, we must use stone. Isn't that a fact? That has been the case in our locality. Wouldn't it have been, possibly 10 or 15 years ago, more reasonable to think that the waterproofing of the earth road surface is more feasible than to send a wireless telegram across the Atlantic Ocean, and yet the wireless has been accomplished, and the earth road problem has not. Gentlemen, it is the thought, and I earnestly appeal to the highway commissions and engineers of the different states from the viewpoint of the farmers who provide the essentials of life for all, to give that line thought. The farmer is directly interested in the road with which he every day comes in contact. It seems to me that the earth road in our state—I am sure in our locality—could be brought up to a high standard of efficiency with less money than what is being used at the present time. There is a reason, and we have heard it mentioned here several times, and I may say in my estimation it is mixing too much politics and water in the roads. I am sorry for that, instead, we should have deep thought and energy. I think it is our duty and the duty of all who claim not to be influenced by politics but as public servants, to give the matter thought from the viewpoint of the farmer. We have also heard from the able professor of the University of Illinois, who said the man who gives receives. We are not on the

question for that purpose, but we want to see that the public has the benefit of good roads. Being one of them, I have reached down in my own pocket to come out here and get the thoughts and rub elbows with you from all over the states, and exchange ideas and I feel I will be greatly rewarded for having come here and I hope you will all feel the same. I thank you, gentlemen. (Applause.)

CHAIRMAN MEEKER: Gentlemen, I have a telegram from our former President, Samuel Hill, to this convention.

Convey to Convention assurance of my best wishes for successful meeting. This is the first time I have failed to attend a meeting, reason being the pressing needs of Belgian friends. Am chairman of the Oregon Belgium Relief Committee and felt my duty here. My heart is with you and my disappointment at not being there in person is great, and much greater than I can express.

SAMUEL HILL.

There is one gentleman here who wishes to speak to you for a few moments on this earth road question, Mr. J. H. Marsh, of Oshkosh, Wisconsin.

J. H. MARSH (Oshkosh, Wis.): Mr. President and Gentlemen of the Association: It gives me a good deal of pleasure to meet you here in the City of Chicago. I started out pretty nearly 40 years ago up in North Wisconsin and hewed our way right through the brush before there was a particle of roads made, and if you think we didn't appreciate roads after we got them, why go up and go a little farther back and get where there is brush and try it. Now, there is one word this gentleman said about clear gravel. I wish that I could add just ten times to what he said. Every man that builds a road, and I don't care whether he is in Michigan, Wisconsin or Illinois, don't use clear gravel unless you want it to shove each way off the road or go down through it. Put your red clay into it and if you haven't got red clay, some other good solid substance, and work it in as you put your gravel on the road. Don't attempt to do it before that or after doing it—just do it while you are putting it on. Mr. Baker gave a very able talk on a good many points that it would be impossible for me to touch on, as I received my appointment from Mayor Maltby of Oshkosh while I was away in the northern woods and therefore was able to get no data on what we are doing. You must therefore pardon me for anything I omit along those lines. I am not educated in the making of paved roads such as have been talked of here today. It has been my experience from the time I went up in that northern country, to build roads with dirt and gravel and whatever we have at hand. There are a

good many new roads to be built even in an old state so I trust that some of my talk may be of interest to you. Is it possible, gentlemen, to realize the difference in our roads of today and those of 40 years ago? When I moved my family into that new territory we chopped our way around windfalls and bad places to get to our newly selected farms. In one year we had town roads that were passable but not good.

One of the first things to think of, and a pretty vital thing, too, in beginning a road where there has been no road, is, are you on the line? Are you making the road around some place because it is a little easier, because it is partly chopped out by some old lumber man? Be sure you are on the line. Another and a very important thing is that these roads, when they are rebuilt on corrected lines, cost the community a whole lot of money. Whatever you do, make your road wide and straight and the driver will level the ruts. There is no doubt but a good many things said by the other friends of the good roads association will apply to most of the vital points I wish to make. Thirty to forty years ago it was quite customary to build roads in the most convenient place. Then as the country developed it was necessary to change many of them to the correct lines at great expense. I always advocated putting the road on the line. Make a wide, almost flat turnpike. This can always be added to.

The material at hand has a great deal to do with the way the road should be made. Wherever it is possible in making a new road the surface should all be plowed. All the knolls should be well leveled down. This causes the whole surface to settle alike, making a very good bed for a dirt road. Almost any kind of dirt is good enough for filling and the leveling up to within 12 or 18 ins. of the top. Then where red clay or other heavy soil or dirt can be had a good liberal supply may be used, always keeping the surface well dragged with a single-tooth harrow. Then apply from 6 to 12 ins. of gravel, not too coarse. A little red clay mixed in with the gravel is a very good thing. To build a good road over a swamp or soft ground, spread 6 to 8 ins. of almost any kind of brush, then dig the ditches and throw the soft ground onto the brush. This makes a good safe place to drive on and drop the clay which should be 12 to 16 ins. deep. When this is well dragged, cover with gravel. No turnpike should be less than 18 ft. in width, and across swamps and bad places the width should be 20 ft. Culverts should be made of stone and cement with a good supply of

sand to hold the stones firmly in place, or else entirely of concrete. There have been a good many of these concrete culverts built in Wisconsin during the past few years, but one serious mistake has been made: This is in setting up a 3-ft. or 4-ft. block at the end of the culvert. This is a bad thing to run against with a team or an automobile and is wholly unnecessary. If the same amount of concrete were used in making the culvert longer it would show the end of the culvert just as well and the place for the water to run through would be larger. If you have a piece of old-fashioned corduroy across a miry spot, cover the logs with 6 or 8 ins. of brush and then spread on 10 or 12 ins. of clay or other heavy soil.

Where a turn in the road has to be made on the brink of a high hill and it becomes necessary to bank the outer edges, the outside of the grade should be somewhat higher than the inside. I thank you, gentlemen, for your attention. (Applause.)

CHAIRMAN MEEKER: Gentlemen, Mr. Richard Lamb, an oil expert on the treatment of wood blocks, has come nearly a thousand miles to give us a little of his experience on the kind of oil that should be used in the treatment of wood blocks. We will now hear from Mr. Lamb who will give us the benefit of his researches and experience.

RICHARD LAMB (Consulting Engineer, New York, N. Y.): Mr. Chairman and Gentlemen: I hate to take your time, but having come quite a distance and considering this an important matter in the wood block paving business in this country, I felt that I would like to say a few words on the subject. The paper I have prepared refers to the oil for wood block paving and has particular reference to that used in Newark, which was mentioned in the paper.

Mr. Howell has given us an interesting and valuable discourse upon a specific example of wood block paving. I will not ask for the time to discuss the merits of the Broad Street, Newark, pavement in regard to a number of its features, but I consider it of great importance to the members of our association that the subject of the oil that was specified for the treatment of the blocks be brought to your attention with a view of bringing out a general discussion of the proper kind of oil to be used in the treatment of wood paving blocks.

I was retained by Mayor Haussling, of Newark, to pass upon the specifications for the Broad Street pavement, and I reported to him in detail upon every feature of the same,

and I have watched the progress of the work during its construction. There were features of the specifications to which I took exception, but none more strongly than that of the oil to be used. The first draughting called for an oil with a minimum specific gravity of 1.08, but when complaint was made that the heavy oil barred competition it was modified, setting the minimum weight at 1.07, but the percentages of the different fractions were still kept at figures that called for by-product coke oven tar oil. While the maximum specific gravity of real creosote oil is 1.08 it is seldom obtained so heavy and the percentage of the distillate up to 315° C. is seldom if ever less than 65 per cent., while the specifications give a limit of 55 per cent. The original specifications called for the old tar, heavy oil, figures of not more than 40 per cent.

I ask the engineers of this convention to learn what is needed in the way of wood preserving chemicals and demand that certain percentages of these chemicals are to be in the oil, regardless of their weight and the source from which they are derived. The physical feature of specific gravity injected into the specifications misleads the engineers who are not chemists and complicates a simple prescription of obtainable percentages of desirable chemicals needed to preserve wood. By having a complicated formula engineers have been led to specify a preserving oil that is inferior.

It is not an important matter what corporation furnishes the oil for our wood blocks, but we engineers are vitally concerned, in the interest of good and economical street paving, to see that no one corporation controls the supply of the oil we specify to the extent that it can place an arbitrary price upon a feature of the business that will enable them to control the same.

The first question is, has an arbitrary price been put upon the tar oil heretofore called the heavy oil? Coal tar oils are obtainable from gas houses and by-product coke oven plants. The oil needed to meet the Newark specification is practically only obtainable from by-product plants. The following are the analyses of preserving oils as made by Chas. N. Forrest, Assoc. M. Am. Soc. C. E.

	Creo. oil	Coal tar oil.	Water gas tar oil.
Original spec. grav.	1.04	1.122	1.14
Fraction dis. below 315° C.	84.8%	34.2%	16.0%
Fraction dis. above 315° C.	13.8%	41.8%	54.3%
Total dis. from oil	98.6%	76.0%	70.3%
Coke remaining in retort	1.4%	24.0%	29.3%

You will note that a minimum specific gravity of 1.07 as specified bars average creosote oil, and a minimum of 30 per

cent. and a maximum of 55 per cent. distilling below 315° C. as specified bars creosote oil and water gas tar oil. Therefore only the by-product coke oven or heavy coal tar oil meets the requirements.

Practically all of the by-product coke oven plants in the United States sell their tar through one concern. This same corporation also sells by far the greater part of all the creosote oil used in the United States. The consumption of creosote used in the United States in 1912 is estimated at 78,000,000 gals., of which about three-fourths was imported. It has been estimated that during the year of 1912 the operating by-product coke ovens in the United States had a capacity of 35,000,000 gals. of tar. The following is an analysis by Lunge of coke oven tars:

Light oils	1.26%
Creosote	21.80%
Soft pitch	74.41%
Water and loss	2.53%

If you had 35,000,000 gals. of the above materials to sell which material would you endeavor to get the engineers to use in wood blocks for paving, the 21.80 per cent. of creosote or a mixture of about 34 per cent. creosote and 65 per cent pitch? You will note that only about one-quarter of creosote can be obtained from the tar, and the demand is so great for this material that we have to import three-quarters of all we use. We export pitch. Therefore by the law of supply and demand the creosote should cost more than the pitch oil. But the selling company has arbitrarily set a higher price upon the pitch oil. In spite of the fact that the company buys its by-product coke oven tar at from 2¼ to 2½ cts. per gal., after distilling out valuable attributes it sells or offers the remainder to the outside dealers for from 8½ to 9 cents. per gal., while they sell the creosote oil at from 7 to 8 cts. per gal., and we sometimes import creosote oil at 6½ cts. per gal., delivered in the United States.

The second question is, is the creosote oil intrinsically more valuable for wood preservation than the pitch oil? The cause of decay in wood is due to the action of bacteria. Some claim that spawn is wafted to the wood and it attaches itself thereto and germinates the bacteria of decay. However, we have all observed that rotting often begins within the wood where no spawn from the exterior could influence it. The decomposition of certain chemicals, such as the albumen in the sap of the wood, by being alternately made wet and dry undoubtedly forms the bacteria of decay. Wood kept always wet or always dry does not decay, and

the extraction of the sap albumen from the wood will prolong the life of same. Bethel, whose cylinder process for creosoting wood is used by all wood preservers, first used carbolic acid which coagulated the sap albumen, and sterilized the wood so that bacteria did not form. This was very effective, but carbolic acid being very volatile evaporated and left the wood. Carbolic acid is one of the first of the distillates of coal tar to come over. It is produced at a temperature of from 110 to 225° C.

The eminent English authorities on wood preservation, Boulton, Dr. Tidy, and Sir Abel, demand in their specifications that not less than 8 per cent. by volume of tar acid of phenols which are the carbolic series, be in the creosote oil. In the oil I used in a large contract for the City of New York, where creosote oil of 1.03 to 1.07 specific gravity was demanded, the specifications called for not less than 6 per cent. of phenols. The carbolic fractions are unquestionably the best germicidal attributes of coal tar, but since they leave the wood by evaporation quite early, their use is becoming less common. The old couplet expresses this aptly: "Why was it ever begun for if it is so soon to be done for."

Unquestionably poisons are needed to kill the germs of wood decay. The only successful wood preservatives are deadly poisons. Burnettizing or zinc chloride; Kyanizing or bichloride of mercury; Thilmany or sulphate or copper; cyanide and the Bethel or creosote processes all use deadly poisons. Creosote has been determined as the most successful preservative as it remains in the wood, and it has been known to preserve wood for a life of about 70 years. At the works of one of my clients they have been using creosote oil from 1.03 to 1.08 specific gravity for 31 years and no wood they have ever treated has shown signs of decay. In the creosoting works where wood blocks are treated with pitch oil where they also do a general wood preserving business of treating ties and timbers, they always use the 1.03 to 1.08 specific gravity creosote for the latter work exclusively. In the distillation of coal tar the deadliness of the poisons is inversely as the increase of heat. When you get beyond 360° C. you are producing tar or pitch. Every boy who has played around a shipyard knows that you can chew tar without injury to your health. If one were to swallow a spoonful of creosote he would never reach home to tell what happened to him.

The creosote oil should contain at least 25 per cent. of naphthalene. In the treatment of timbers the government sometimes demands as high as 42 per cent. naphthalene. A

specification from the United States Navy Department, just received, calls for North Carolina pine piles to be treated with 12 lbs. of oil per cu. ft. The whole specification for the oil reads as follows:

The oil shall not flash below 185° F. nor burn below 200° F. and between 410 and 470° F. the yield of the naphthalene shall not be less than 42 nor more than 60 per cent. by volume.

Paving pitch contains only from 8 to 15 per cent. of naphthalene. Because of the similarity of the name naphthalene and naphtha, the former is supposed to be very volatile like naphtha. Such is not the case. Naphthalene has been found in treated timbers of 40 years and more of service. Pitch is like resin; in fact, melted resin is pitch. You have observed how a hard pine board in which there is much resin will continue to exude pitch when exposed to the sun. Pitch treated blocks also continue for years to exude pitch when exposed to the sun. Who will say that this does not mean that the preservative, so called, is leaving the wood? It is true that when treated to supersaturation with say 20 lbs. per cu. ft. of light creosote oil in hard pine, the oil will bleed for about a year, but after that it stops exuding. This bleeding when it comes out on the sides of the blocks mixes with the sand filler and makes a mastic that binds the blocks together and waterproofs the joints.

We engineers are asked to specify as our wood block preservative a material that has been hard to sell for other purposes. We have been given no valid reason why we should not specify the same preservative for our wood blocks as for our ties and timbers. It has been contended that the blocks will wear out before they will rot out. If so, why use any preservative at all? In fact, there are creosoted wood block pavements that are 40 years old and are still perfectly good. It has been contended that the pitch oil will caulk the pores and prevent buckling. My observation has taught me that the pitch oil blocks buckle and the creosote oil do not. The reason of this is that the pitch hardens in the block and does not allow for the take up, within the block itself, of the expansion. The creosote oil with the sand filler forms a mastic that does permit of the contraction of the block itself when pressed against its neighbor while expanding. But the phenomenon that is the most important of all is that pitch expands excessively while creosote expands but slightly when subjected to a cold temperature. In the majority of cases in the Northern pavements, buckling does not come from the absorption of water from rain

storms, but during cold snaps. If the blocks are laid tight and the street well graded the water will run off the surface before it will soak into the blocks, especially after the traffic has worn the surface to a hardened and closed condition. I was called to remedy a pavement laid with pitch oil blocks on a grade, where the blocks had buckled three or more feet high. I noted that there had been no rain storm, but a sudden freezing spell. Think of how much water would have to soak into the blocks which passed rapidly down grade over the same, in order to make them swell three feet high.

If a real preservative like creosote oil is used, sap or short leaf pine can be used. It will be found that this wood will permit of squeezing together of the wood of the block and this prevents buckling. There is a saving of about 15 cts. per sq. yd. in the use of short leaf over long leaf pine. It takes the treatment better and will not erode like the harder woods. But don't use short-lived wood unless you specify standard creosote oil, a real preservative. The Europeans use Baltic pine which is like our short leaf pine, and they preserve the blocks with creosote oil. At first, they used hard woods, but the soft woods are now being generally called for.

I wish to bring most particularly to your attention one clause usually inserted in the tar oil specifications which in my judgment should be excluded; that is the requirement that in three analyses of the oil the fraction distilling between the temperatures of 255° to 315° C., at 60° C. should have a specific gravity not less than 1.02. The basis for this feature of the specifications is gotten from a circular published a few years ago by the government in which after making four or five tests the experimenter thought that he had discovered a way to differentiate between a coal tar product and a water gas tar product. It was well understood that the old test, the sulphonation test, is not at all reliable in making that determination. I wrote to the U. S. Government Forestry Department, who had issued the above referred to bulletin, and received the following reply from the Director: "You must be misinformed as to the formula for differentiating between water gas tar oils and coal tar oils. As far as I am aware, there is at present no means of doing this with certainty. At one time this laboratory believed that certain physical and chemical properties of the oils would serve as a method of identification, but more recent work by this laboratory has shown that the chemical and physical properties of certain

water gas tar oils are nearly identical with those obtained from coal tar."

The fraction referred to when under 1.02 specific gravity would be of the aromatic series, a toxic, and desirable for preserving wood. Oil from either coal tar or water gas tar will vary in specific gravity in this particular fraction, according to the varying intensity of the heat in the original formation of the tar. The regularity and intensity of the heat in a by-product coke oven produces a tar that gives over 1.03 specific gravity in the fraction between 255° to 315° C. at 60° C. What justification therefore is there for rejecting an oil because it fails to meet this arbitrary physical feature unless it is to demand that only the product of coal tar from a by-product coke oven can be furnished? This unjustly limits the available supply of oil.

What I wish to impress upon the convention is that, in spite of the prejudice heretofore existing against products of water gas tar, they are equally as good as coal gas tar after they have been derived. Water gas is an infant industry compared with coal gas, and the corporation selling the coal gas tar product has kept up a warfare against water gas tar unwarranted by the facts.

Neither water gas tar nor coal gas tar, per se, have any of the constituents that go to preserve wood. It is only after the molecular attraction is disturbed by varying degrees of heat and the molecules rearrange themselves with reference to the affinities among themselves, established by any given heat, that the particular toxic chemical is formed. Some coal gas and also water gas tars, because of the heat at which they have been formed, do not lend themselves to the liberal production of one or another of the valuable preservative distillates, such as naphthalene, anthracene, etc. But as much of these products can be secured from one form of tar as from the other, and who will say that it makes any difference to the user if his naphthalene or anthracene comes from water gas or from coal gas tar? They are identical after they have been made. We should specify what the various fractions shall contain, and they can be obtained from either kind of tar with only the amount of pitch we are willing to accept included in the same.

Most of our gas houses are using both the water gas and the coal gas processes, as the coke from the coal gas retorts can be turned into water gas at a great saving in the making of same. The resulting tar oils are often mixed. Refineries test samples of these tar oils and if they analyze

so as to insure their making the proper quantities of the products they wish to manufacture they buy the oil regardless of the process by which it was made.

Let the engineers of this country stop allowing the coal tar corporation through its extensive advertising propagation, personal solicitation and public addresses blind their eyes with the statement that by-product coal tar product is the only thing to use in wood block manufacture, and let us engineers open our specifications to get what we need from whatever source it may properly be derived, and the supply of oil will be so augmented that the price of same will have to be reduced and we can lay roads as well as streets with this most satisfactory of all surfaces, creosoted wood blocks.

CHAIRMAN MEEKER: Mr. Thomas H. MacDonald is not here to read his paper on "Street Paving in Small Cities," but has handed it to the Secretary. It will, therefore, be printed in the proceedings.

I wish to announce at this time that the convention will go into executive session at the conclusion of this afternoon's session. It is a business meeting of the American Road Builders' Association. I further announce that the nominating committee will meet at this room at two o'clock. The meeting for this afternoon is called for half-past two, but I doubt whether we can assemble at that time. I will now declare this morning's session adjourned.

Street Paving in Small Cities

By THOMAS H. MacDONALD
State Highway Engineer of Iowa

No very definite limit has been been fixed as to the point at which the large town caterpillar becomes the small city butterfly. Very much depends upon the point of view. No one will seriously question, however, the right of any corporation, no matter how small its population, to call itself a city, if it may point with pride to even a single paved street. Towns may have electric lights, water works, and sidewalks by the mile, but paved streets, never. Legislatures may write into the laws of the state the limits of population which determine the legal status of towns and cities; but no law can change a sleepy country town into a thriving little city.

Paving promoters are more successful. This conclusion at least must be reached if we believe that the first broad public service that any municipality renders is the building of

good streets. All the other first improvements serve the more selfish welfare of the individual and the town.

Improved streets serve the best interests of the whole community. Their benefits are neither selfish nor individual. Their usefulness is not limited to those who live within the corporation boundaries, but rather is extended to the whole surrounding territory.

That street improvements should be made by the cities and towns in agricultural communities as rapidly as possible seems only fair, for such improvements provide direct and reciprocal benefits to the agricultural communities upon which so much of the prosperity of these municipalities is dependent.

As indicated by the title, this discussion is limited to small cities. Such a division might easily include the cities of twenty-five to fifty thousand people.

Cities of this size have a sufficient support fund to secure competent technical service, and property values are able to withstand paving assessments. There have been volumes written concerning all angles of the paving question, which are applicable to cities of this size.

There are, however, almost innumerable small cities which have serious paving problems, and which have not received due consideration.

Because of the large number of these little cities, their aggregate importance to the individual states, and their difficulties in making such improvements, this discussion has been purposely limited to the very small cities.

During the five year period from 1909 to 1913, there were 40 towns in Iowa of less than 15,000 people which built in that time 1,640,000 sq. yds. of pavement of six standard types. The smallest of these towns had only 1,200 people, the largest 14,600, and the average size for the whole number was 4,300 in 1905, increasing to 4,600 in 1910.

It is believed that this average small city is representative of many hundreds all over the United States, but particularly in the Mississippi Valley states, where agricultural conditions are similar.

Each little municipality serves a community within a radius of about five miles, and carries on a small manufacturing business. Railroads or electric lines extend the trading radius in certain commodities for perhaps ten or fifteen miles.

Forty such towns for which the correct totals are available have built in five years, the following pavements:

Creosoted wood block	70,300	sq. yds.
Sheet asphalt	107,700	" "
Bitulithic	201,700	" "
Asphaltic concrete	256,500	" "
Brick	484,600	" "
Cement concrete	519,000	" "
Total	1,639,800	" "

In addition to these types there has been a small yardage of other roadways, which are not recognized as standard pavements.

The problems that these municipalities have to meet in obtaining street improvements are grouped as follows:

Lack of experience with pavements of any character.

Lack of an adequate engineering organization.

Property values and property income are low.

Area incorporated is excessive compared to population.

Plans adopted are imitative of larger cities rather than designed to meet small city requirements.

Contracts have small average yardage.

Lack of any comprehensive improvement plan.

To meet these problems the city which builds its first pavement does not have the advantage of the experience which the larger and older cities have obtained as to the best possible types of pavement to use. There is also a lack of an adequate engineering organization. Although a competent city engineer may be employed, the chances are against his having had any wide experience with various forms of street surfacing, and local laboratory facilities are almost entirely lacking.

Property values, comparatively speaking, are low, and the income from the property does not pay a high per cent. on the investment. The average small city has its corporate boundary lines extending far into the sparsely settled surrounding territory, so that its area in ratio to its population is very large. This is one of the penalties which is always paid when a municipality reaches out for more land to tax. The income is not proportional to the required outlay when adequate improvements are made.

When the city is without experience with pavements of any character the first plans adopted have nearly always been imitative of some of the larger cities. It has not been an uncommon occurrence for committees appointed from the representative citizens, the councils or the commercial clubs of small cities all over the Mississippi Valley to visit Minneapolis, Chicago, St. Louis, or some city of equal impor-

tance, in order to study types of pavement adapted to their home city of five to fifteen thousand inhabitants.

Another factor which has been a real difficulty is the average size of contracts which are awarded in the small city. From the data available—which are accurate for the past five years—the following results are secured:

For the construction of brick and vitrified brick pavements, contracts average as follows:

1909—Six	contracts,	average	of	15,200	sq.	yds.	each
1910—Seven	"	"	"	13,300	"	"	"
1911—Twelve	"	"	"	11,200	"	"	"
1912—Three	"	"	"	13,500	"	"	"
1913—Ten	"	"	"	11,500	"	"	"

In the construction of asphalt pavements this fact has been even more striking. A comparatively expensive plant is required, and contracts have been awarded as follows:

1910—One contract, 10,000 sq. yds.
1912—Two contracts, average of 40,350 sq. yds. each.
1913—One contract, 17,000 sq. yds.

In the construction of creosoted wood block pavements, contracts have averaged as follows:

1909—One contract, 12,470 sq. yds.
1910—Three contracts, average of 16,980 sq. yds. each.
1911—Two contracts, average of 3,530 sq. yds. each.

In the construction of concrete pavements contracts have averaged as follows:

1909—Two	contracts,	average	of	3,500	sq.	yds.	each
1910—Three	"	"	"	14,200	"	"	"
1911—Six	"	"	"	13,000	"	"	"
1912—Six	"	"	"	33,350	"	"	"
1913—Eleven	"	"	"	17,500	"	"	"

In the construction of bitulithic pavements, contracts average as follows:

1909—One	contract............	14,000	sq. yds.	
1910—Two	contracts, average of	56,500	" "	each
1911—One	contract............	17,000	" "	
1912—One	contract............	6,000	" "	
1913—Two	contracts, average of	25,500	" "	each

In the construction of bitulithic pavements a complete plant is required, even for small contracts.

In the construction of asphaltic concrete pavements, contracts average as follows:

1911—One	contract............	1,100	sq. yds.	
1912—Four	contracts, average of	39,000	" "	each
1913—Five	" " "	21,600	" "	"

In the construction of asphaltic concrete pavements a complete plant is required, regardless of the size of the contract.

It must be again accented here that this discussion is based entirely upon the actual street improvement record of forty small cities in an agricultural state, and that the facts apply

only to conditions of this kind, and not to street improvements in the larger municipalities.

The average size of the contracts, as noted above in detail, it will be admitted, is not sufficient to attract a class of contractors who will devote the best services of their organizations, nor can they supply as complete equipment as is possible on larger contracts.

Another serious problem which the small city necessarily meets is the lack of any comprehensive improvement plan. Frequently the paving program begins with the improvement of a single street, and may not be resumed except in a desultory piecemeal manner. The actual amounts of paving laid do not show any continuity or regularity, but rather a most haphazard plan.

There are in the list of the cities from which these records are taken, a few important exceptions. For instance, one contract was let by one city for nearly 100,000 sq. yds. of one type of pavement. In that case a comprehensive plan was adopted, and the results secured satisfactory.

It will be noted that the entire paving program of these forty representative cities was really based on the standard types of pavement that have been developed by large cities, where traffic requirements are heavy, where property values are high, and the incomes from the property much larger. The street improvements of small cities should not be imitative. The difference in traffic requirements, costs, and future development should each be studied in its true relation and true proportions. The type of pavement which makes a beautiful street in some large center of population is not necessarily the proper improvement to place on the average small city thoroughfare. In fact, if street improvements of this character must be carried on in imitation of the larger cities, then the improvement of many streets, which to be useful to the community must have some surfacing, will be long delayed.

Practically every small city has three quite distinctive types of roads. The business streets proper, the residential streets and the main market roads extending into the surrounding farming community, and forming also a part of the network of main county and state highways. While these three classes of streets may not demand different types of pavement on account of the traffic requirements, they do require different treatments on account of the financial requirements.

The business street of a small city demands a pavement that can be easily cleaned, that will not be injured by large quantities of mud tracked on the surface, that does not in

itself originate dust, and that needs a minimum of repairs. If these requirements be met, the cost is not so important, for property values and property incomes are high enough to justify the cost of any of the standard types of pavement. Taking all these factors into consideration, probably the most economical and satisfactory form of pavement for the business streets of the average small city is cement grouted brick on a concrete base.

The residential streets must be studied very carefully. There are very few small cities which have any extended residential districts to improve, in which the cost is not the first consideration. On the main through roads connecting market centers and towns, reasonably wide pavements must be used, but outside of these a single roadway with wide parkings, or a double line of narrow pavement, with a wide center parking should be used to reduce the cost. In the districts where rents and property values are highest, some form of bituminous pavement may be used. For the other districts, bricks, concrete or bituminous coated concrete should be used.

The paving of the main market or country roads through the sparsely built district encountered just within the corporate boundaries of every small city, is usually the most difficult to finance. This has been partly because the improvements have been estimated on the basis of a wide roadway. The actual traffic census over such a road in an average small city showed approximately 900 vehicles of all characters daily. If this is representative, it would be proper to build, beginning with the sparsely settled district, a double track roadway of brick or concrete, and widen the shoulders with gravel or stone, thus treating the street as a main country thoroughfare. In this way such an improvement would not become a financial impossibility.

SEVENTH SESSION, 2:30 P. M.

CHAIRMAN CROSBY: Gentlemen, the hour for the meeting has arrived and more than arrived. At the morning's session because of the limited time we were unable to reach the topic of "Street Paving in Small Cities." The paper on this subject by Mr. MacDonald of Iowa has been received and will be printed, but in order to save time and as Mr. MacDonald is not present I will call on or ask for the discussion to proceed at once. The first gentleman on the list for the discussion is Mr. Boley, of Wisconsin. Is Mr. Boley present? Is Mr. Cairns of Waterbury, Connecticut, here? Is

Mr. Anderson of Illinois here? Is Mr. Hunter of Pennsylvania here? Apparently not.

Now, discussion from the floor is in order and any gentleman who cares to speak upon this subject I am sure the convention will be very glad to hear. I understand that some discussion had practically been promised. I hope that it will be forthcoming. The subject is an interesting one.

If there is no discussion we will proceed with the regular program of the afternoon. The first topic is "Convict Labor in Road Construction." This is a very interesting subject to a great many of us, I am sure, and the paper listed is a paper by Mr. T. J. Ehrhart, State Highway Commissioner of Colorado. I regret extremely that Mr. Ehrhart is not here because Colorado has had some very interesting experiences in convict labor. Mr. Dickson, will you speak to us?

MR. WILLIAM DICKINSON (Ridgway, Pa.): I have built 28 concrete bridges. I am thankful today that in every one of those 28 bridges my heart was in the work. From the start I saw the necessity of giving concrete its utmost good, taking the highest grade of concrete that could be made, if it was going into bridge construction. I was pained here the other day when I heard two or three gentlemen speak against the idea of permanency. It hurt me. I would build a bridge as I would a good road, keeping in view permanency. It is well to place our goal just as high as we can.

Now, what I most earnestly wish to do is to bring up some mistakes that I have found in the making of concrete and in specifications. All specifications should contain a requirement for clean sand. A little farther along you see, as the gentleman from Ohio read the other day, it must not contain more than 8 per cent. of clay. Why any clay? Why one per cent. of clay? I have conducted experiments along that line that have been expensive, that have been exhaustive, and I know that any amount of clay whatever in sand is deleterious. Clean, sharp sand is as necessary in the mixture as it is in the contract. Now, another thing in regard to sand. All sand has more or less fine, floury dust; sand from crushers, I mean. It should be eliminated. I know that a great many will not agree with me when I say that clay is deleterious, but before any of you put up a great, big hoot of derision satisfy yourselves by actual demonstration that I am in error and I will stand discredited.

Another point is with gravel. Round gravel—I am speaking now of concrete in its highest efficiency—round gravel is worthless for concrete, but if it is hard and crushed it is one

of the finest materials in the world. I claim that every particle, fine or coarse, should be sharp and jaggy. Clay or dust in sand is on a parallel with the man who experimented through the hard winter in feeding his cows. He told his wife about Christmas that he had really come to the conclusion that the more sawdust he put in the corn meal the better they would thrive. It is the cement that does the work. I guess that is all along that line.

You can't make concrete any harder than the aggregate you use, and the harder, the rougher, the more angular that is, the better. Sand and concrete both should be graded. You can readily understand why. The better it is graded the less the voids; the more strength you have from your cement, your cement reaches farther. (Applause.)

CHAIRMAN CROSBY: I am sure we all very much enjoyed hearing Mr. Dickinson, and he expressed some very sound views in an unusual way. Now, we got a little off the track of the program, and I suggest we come back to the program itself and carry that through, and then if there are any outside matters which are of interest I am sure the convention will be glad to hear them and discuss them to the extent of time and ability afforded. The subject for discussion now is convict labor in road construction. Mr. Williams, will you kindly lead the discussion?

A. D. WILLIAMS (Chief Road Engineer of West Virginia): Has the main paper been read?

CHAIRMAN CROSBY: The main paper of Mr. Ehrhart's has not been read. If you prefer I will have it read.

MR. WILLIAMS: I believe it would probably be better to have someone read the paper, inasmuch as I have prepared no paper. Then we can strike into the discussion.

CHAIRMAN CROSBY: The man I relied on to read the paper has disappeared, has taken advantage of my back being turned, so with your permission the Chair will make the attempt. The paper is by Mr. T. J. Ehrhart, State Highway Commissioner of Colorado. "Convict Labor in Road Construction."

Convict Labor in Road Construction

By T. J. EHRHART

State Highway Commissioner of Colorado

The question of convict labor is a very important one, involving as it does in our state, the welfare, care and treatment of some eight hundred men, and also the consideration

that must be given to the matter of avoiding, as far as possible, competition with the free labor outside the prison walls. The involuntary slaves of the commonwealth who are confined for specified terms in the State Penitentiary, are entirely in the hands of and at the mercy of the government of the state.

The question may arise as to whether confining these men is a punishment and only that, or whether they are confined for the purpose of simply protecting the public from further crimes on their part, with the hope that a period of imprisonment will work a change in their moral nature, such that at the end of their term they will have ceased to be a menace to the community. If the first idea is the only one, that is, that the committing of a crime must be punished, and that punishment is by confining a man at hard labor for a certain term of years without considering in any way the possibility of changing his nature so that he may cease to be a criminal upon his release, then the proposition would resolve itself into the state simply guarding these men and getting all they could out of them, without any regard to the effect upon the men themselves, turning them loose at the end of their term in practically the same or worse condition than they were when they entered the prison.

It seems to me that the other view must be taken; that is, that every effort must be made during the term of imprisonment, to correct the criminal impulses, and nourish and encourage the growth of moral restraint, so that the prisoner can be usefully employed, and leave the prison a law-abiding person.

It is necessary that whatever work the prisoners are placed at should be of a useful nature, and be of some benefit to them upon their release.

Many different forms of employment for the prisoners have been tried in the various states of the union, from the contract system, where the labor of the men is contracted to certain parties at definite sums for certain definite periods; the shop system, where the prisoners are employed inside the prison walls at such work as can be secured by the state, such as garment making, shoe manufacturing, and making of other utensils and clothing. In addition to these forms of labor, there is certain necessary work about the prison, requiring the use of quite a number of men in the bakery, laundry, necessary repairs in the buildings, the care of the livestock, and the care of the prison grounds. These are incidental employments which take care of a small number of the total number confined.

It seems to me that the method of contracting to individuals the labor of the prisoners has always resulted in dissatisfaction, mistreatment of the men, and that as far as the prisoner himself is concerned, it is one of the worst forms of labor that could be devised.

The making of garments and implements by the prisoners for sale on the markets has also been objectionable, both of these forms being competition with free labor.

In Colorado we have the prisoners doing the necessary work about the penitentiary, including the construction of additional buildings, cell houses, hospitals, etc., and also a good sized farm, upon which many of the prisoners are employed during the season.

In addition to this, beginning in 1899, the State started to use the convicts upon the construction of roads of the state.

The first work, in 1899, was done in the upper Arkansas River Valley, in the neighborhood of Buena Vista, under a bill introduced in the Legislature by the writer. In this year considerable work was also done in Fremont County by the convicts. Later, in 1905, a bill was introduced by Senator Lewis, and another one in 1907 by Senator Barella, the latter bill providing for a convict built road from the New Mexico state line at the south, to the Wyoming state line on the north. The Lewis bill is the one under which our convicts are now being successfully worked on the roads under the present administration. Copy of this bill follows:

S. B. No. 224, by Senator Lewis.

AN ACT

Providing for the working of convicts in Colorado State Penitentiary upon the Public Roads and Highways within any county and upon the streets and alleys within the cities and incorporated towns located in the State of Colorado.

BE IT ENACTED BY THE GENERAL ASSEMBLY OF THE STATE OF COLORADO.

Section 1: Upon the written request of a majority of the board of county commissioners of any county in the State of Colorado, the Warden of the Colorado State Penitentiary, situated at Canon City, in Fremont County, shall detail such convicts as in his judgment he shall deem proper, not exceeding the number specified in said written request, to work upon such public roads and highways of such county, or streets and alleys of any city or incorporated town within such county as shall be designated in said written request of said county commissioners. Provided, that such county shall pay all additional expenses of guarding said convicts while working upon said public roads and highways within such county, and shall furnish all tools and materials necessary in the performance of

said work; And, Provided, That when said work is done within the limits of any city or incorporated town within such county, or city or incorporated town where said work shall be done shall likewise pay all additional expenses of guarding such convicts while performing said work and shall furnish all necessary material used in said work.

Section 2: Said convicts when employed under the provisions of Section 1 of this Act shall not be used for the purpose of building any bridge or structure of like character which requires the employment of skilled labor.

Section 3: The Board of Penitentiary Commissioners are hereby empowered to adopt a special rule applicable solely to convicts employed on the public work herein authorized and contemplated, whereby convicts so employed shall be granted additional good time allowance, conditioned upon their good behavior and cheerful compliance with all rules that may be made by said board or said superintendent for the management and control of convicts so employed.

Section 4: All acts, or parts of acts, in conflict herewith are hereby repealed.

Section 5: In the opinion of the General Assembly, an emergency exists; therefore, this act shall take effect and be in force from and after its passage.

Approved April 11, 1905.

Work was started on the main state road from Trinidad to the New Mexico line, and finished in 1907 by Warden Cleghorn. The famous "Sky Line Drive" at Canon City was also completed under Mr. Cleghorn's administration, and the development of the system of working convicts without gun guards and solely upon honor was started by Mr. Cleghorn. Our present Warden, T. J. Tynan, took charge of the work in 1909, and has extended and developed the system, until at this time it is one of the very successful adjuncts of the state system of road work.

We find that a certain proportion of the men confined can be advantageously used without guards on the state roads, working the same as any other road camp would work, under the direction of a superintendent and foreman. At the present time there are about 300 convicts employed on the roads in the state of Colorado. This would be about 30 per cent. of the entire number of prisoners in the penitentiary. The Warden has full control in the selection of these men, taking their word of honor that they will not attempt to escape or go away, and the fact that less than 1 per cent. of the prisoners employed on the roads during the last six years have attempted to escape, amply testifies to the manner in which the prisoners keep their word. There are no armed guards of any kind employed at any of the road camps in this state. The number of prisoners to a camp runs from 25 to 50; there is one superintendent in charge

of the construction and of the men, at each camp. He is assisted by one to three foremen, as may be required, according to the character of the work and the number of men in the gang. The men are absolutely free, except during working hours, but they are required to keep within the vicinity of the camp. The night watchman is, as a rule, one of the prisoners. The men are sheltered in tents, which are provided with stoves, plenty of warm bed clothing, and they are also furnished good substantial clothing from the penitentiary; they are also furnished tobacco, plenty of good food, with the extras of the season; have their ball games and other sports on holidays, and on Sundays have religious services; when close to streams where fish abound, they have their fishing, and in fact are really enjoying nearly the same freedom, except the ability to leave the camp, that any other man would enjoy at a free labor camp. The open air work is beneficial to their health, they have learned to handle tools, and to do a fair day's work, and the fact that they have been trusted and earned the regard of the officials in charge, most certainly has had a beneficial effect upon them.

The state pays no wages or per diem to these men, but allows them, under the law and the regulations of the penitentiary officials, an allowance for their work, which taken together with allowance for good behavior, practically cuts their minimum sentence in half.

As far as the effect upon the prisoner is concerned, their employment upon the roads is absolutely a success, and even were there no profit to their employment to the state, outside of that, I believe it should be continued for that reason alone, but the states does get returns from the men by the work accomplished. The records of cost, kept by the camps in our state, show that the total cost per man per day in the camps for food for the prisoner, all extras, such as tobacco, and other incidentals and including the cost of food for the stock employed in bringing supplies and other work, will run from about 60 to 90 cts. per day per man, and the average cost per man per day actually worked on the road varies from about 80 cts. to $1.50 per day. The cost of the work accomplished will, of course, vary with the character of the work and will run from $500 per mile to $5,000. It seems to me from our experience in this state that the economy of the use of prisoners is reached when the road camps contain not less than about 25 to 30 men as a minimum; that 40 to 50 men would be a better sized camp for the reason that the overhead charges are nearly the same in either case, and if the camp is too small, then the overhead charges run too high.

The location of the camp and the cost of transportation of the prisoners going and coming is an item which needs consideration, as if a number of short term men are placed at any great distance from the penitentiary, the cost of bringing them to the work and returning them for a few months' employment would bring the charges up considerably.

Another point that might be mentioned is the employment of satisfactory and sufficient tools and machinery for doing the work. We have found that the employment of drilling machines for rock work is a very economical expenditure, and for the grading, that the use of a road grader and other forms of road machinery are also profitable investments.

Our state has all nationalities represented in the prison, and on our road work; men who have been convicted of all characters of crime against the established rules of society.

In conclusion, in the gradual development of this system of employment of prisoners, which has gone through its various phases in the past fourteen years, we have developed what seems to be a satisfactory method of employment for the trustworthy prisoners, an employment which is far superior to any of the old contract or factory system methods.

CHAIRMAN CROSBY: The paper, as was to be expected, is extremely interesting, and I am sure we will listen now with interest to Mr. Williams' discussion. Mr. Williams. (Applause.)

MR. WILLIAMS: Mr. Chairman and Gentlemen: Looking over Mr. Ehrhart's paper and noting the fact that he was practically the author of the law under which they are working in Colorado, it would rather appear that he is a veteran in the prison labor cause and no great suggestions could be expected from a novice. Yet every observing tenderfoot, as he passes through, has some impressions that he can at least carry with him during the remainder of his life.

Those of us whom you might say are novices in prison labor have discovered some things not covered in Mr. Ehrhart's paper. In the first place, Mr. Ehrhart deals with this subject more or less from the standpoint of the ideal, and I wish to deal with it through experience and observation from the side of the real. There is quite a difference in certain imaginary pictures from those which we really are able to produce, for many an artist has drawn in his imagination the most beautiful scenes, which, when placed on the canvas, presented a great contrast.

The subject of prison labor is a big one. It is a broad one, and, I want to say before entering into the subject farther, it is a deep one. It is a much bigger problem than a great many of us, at first thought, consider it. When we come to consider that throughout the hundreds of years that humanity has been dealing with the question of prison labor and the transgressor of laws, and note how little progress we have made, we then can realize that we are up against one of the biggest problems, possibly, that we are confronted with.

Mr. Ehrhart raises some objection to the contract system. I believe from my limited experience in connection with prison propositions, that I have run up against but few men who have the real conception of the evil of contract prison labor. The idea that is exploited by a great many holding that prison labor in competition with free labor is injurious, is a fallacy when we come to consider that all the prison labor that at the present time is working under the contract system is less than 15,000, and when we come to compare the amount of production by all prison contracts as against the needs and demands we find that it amounts to but little. Therefore that part of it need not be considered. But, gentlemen, the evil, the gigantic evil and the curse of the contract system, lies in the division of authority. You have two lines of authority. On one hand you have the representatives of the law placing on the man a certain amount of pressure to bring about a certain degree of discipline, while on the other hand you have the representative of the contractor striving to get out of that poor unfortunate victim every ounce of energy that he can develop in the period of time that he is in his service. There, particularly, gentlemen, lies the curse of the contract system. There is where the poor unfortunate man who has fallen victim to the grip of the law is being pressed by the weight of the law itself and likewise by the representative of the contractor, who is striving to take from him every particle of energy that he has.

The object of imprisonment or confinement in prison must be resolved into two things: First, to protect society from the violence of the man who has committed the crime. To protect society from a repetition of the same crime that he has once committed. And the second most important purpose for which the prison should be used is to lift that man from the state of citizenship in which he was existing when he committed the crime to a citizen of character, capable of maintaining himself, capable of living a better

life; yea, capable of being a man. Now, when we take these two particular objects as our guide, the first thing that we must consider is the line of employment and the effect of that employment, so as to produce within that man a better character and a better citizen.

Now, you can take any man, I don't care who he is or where he comes from, tie him up to one position, keep him sitting in idleness for a period of time, and during that period that man will deteriorate physically, and by the physical deterioration he depreciates mentally, because of the vitality of the body failing to keep up the necessary cell production to produce the proper mental expansion. Therefore, idle confinement or solitary confinement instead of being a humane proposition, instead of having within it the elements of correction and production in the unfortunate man has nothing except the elements of deterioration, destruction and degeneracy and, when that man is liberated from prison, instead of being a better citizen, a more useful citizen, he is less capable of taking care of himself than when he was first put in jail or prison. Therefore, it is necessary to give to the man who is confined in prison some kind of useful employment.

Then the next question that comes to us is what kind of employment will give the best results? What class of employment can we use to get the best results out of the prisoner so as to make the best man out of him and at the same time as nearly as possible make him self-sustaining during the period he is in the public's care. When a man transgresses a law, immediately that man becomes a debtor to society. He owes society for the transgression of that law because society has made the law for society's protection. Every law that we have is the product of necessity, or believed necessity, when it comes to the question of protecting society, and the man who transgresses the law becomes a debtor not only for the amount of expense necessarily incurred by enforcing the law, but because of the regular and general rule of society; therefore, that man is due to render to society and from the period of his life and from his energy and his service something to compensate for that wrong. There is no other way of measuring. That being true, it is necessary that we work the prisoner so as to develop him, bring him back, that is society's duty to him. Now, how best can we do it?

We cannot, as we have figured it out, use altogether the contract system, because it does not pay to make out of the man a worse citizen than he was before we put him in there.

There is only one way that we can really build up a man, and that is to make it to his own personal, individual interest. There must be a direct appeal to me to get me to act. Something must reach the inner man. Every man that is in prison today has that peculiar and particular individual pride within himself notwithstanding the fact that he has fallen. And another thing: Practically every man who has been convicted of a crime carries a feeling that society has it in for him. He has a feeling that society is his enemy, and that is another side that we must deal with. Now, the best way to get the best results out of a man, as we all know from our own experience, from our own physical being, is open air employment, employment out of doors, employment where the songs of the birds and the whispers of nature lend him inspirations. Possibly there is no other place in which the public, as a whole, has more interest and from which it gets more benefits, than the public road, and for that reason the public road, insofar as the prisoner can be used upon it, is a practical place to use him. But, gentlemen, we cannot expect to use all of the prisoners that we have in any state institution upon the public road successfully and profitably. I believe that Mr. G. P. Coleman, of Virginia, when he said some weeks ago that the prisoners should be divided into four classes, struck the keynote of the prison labor proposition.

Class No. 1 would include second-term men, life-term men and undesirable or dangerous characters. These should be worked inside of some kind of walls where they can be kept under strict guard. Class No. 2, takes in those that could be used in stockades or places where a minimum amount of guarding would be necessary, for the purpose of quarrying stone, manufacturing brick and other road materials. Class No. 3—the honor system men, or honor men, as you might term them—those that could be used upon the public road without guards, but under the direction of a superintendent. Class No. 4, those who could be paroled and used in maintenance. The state or county should provide places for them to live, where their families could be with them, and give them a certain specific territory over which to work. In these you have provided a course of reform—an object for the man to go from one stepping stone to another while under the care and protection of the authorities. He should be protected until he can demonstrate to society his capability of taking care of himself. I do not believe that we can enlarge upon that and make a better system. None of us yet has worked out the ideal way. In many respects we are following the blind paths of precedent.

Now, in West Virginia we have been trying prison labor during the past year, so far as the state prisoners are concerned; but we have been working the county prisoners for some years. The last legislature passed a law providing that the state prisoners should be worked upon the public roads under rules to be formulated by the State Road Department and the State Board of Control which has charge of all public institutions in the state. These prisoners were contracted to the counties, there being no provision to take care of them, at 75c. per day, the county paying for the days actually worked, the state furnishing the guards, all of the supplies and the camp. I have here the report of these camps from the time they began work up to December 1. Camp No. 1, consisting of 30 men, from June 8 to December 1, did 3,534 days' work. It cost $1.03 per day for each day's labor in that camp.

Camp No. 2, of 20 men, cost an average of $1.58 per day's labor. The loss was 56c. per day. Camp No. 3, with 25 men, cost $1.16 per day, showing a total loss of $284.51.

The point I want to make here is that camp No. 1 had over it besides the guards, an engineer to look ofter the work all the time. The state's loss on that camp was $407.

Camp No. 3 had an engineer over it, and the state's loss on that was $284. We worked Camp No. 2 without an engineer, and the state's shortage on that was $1,292. Here is the difference in the management and the handling of the men. This report did not come to our office until after December 1 or, I wish to state to you, that there would have been some remedy before that time. But I want to tell you of our mistakes for your benefit. I do not believe in discussing the ideal always; I believe that oftentimes we can get more good out of some other man's mistakes or our own mistakes than we can from our successes.

Now, as to the efficiency of the prison labor as compared to day labor. We had a chance to try this out side by side, with equal crews on the same class of material, on the same piece of road. The cost of moving and grading unclassified material with prison labor was 30 cts. per cu. yd. at Camp No. 1, and 83 cts. with day labor on the same piece of work. That is, counting the same cost of teams and the same foremen charges against each. The cost of moving unclassified material at Camp No. 3, from the date of the camp's establishment to December 1, the material running about 30 per cent. stone and 70 per cent. earth, was 23 cts., including all overhead charges. We used prison labor also in constructing some culverts of reinforced concrete and that cost us by

prison labor $6.92. The plain concrete in culvert work cost us between $4 and $5 per cu. yd. as against about 60 per cent. higher prices for day labor. Now, the reason for this wide difference can be explained, so far as this comparison is concerned, first, that these particular crews were selected from between eleven and twelve hundred prisoners, they were select men; they were on the job every day and worked faithfully and steadily. On the other hand, the demand from the mines and the oil and lumber regions in our state is such that the better class of laborer has a continuous job, and it is hard to get this labor to work on the public roads. The efficiency of the prison labor as here compared is with the best select bunch of prisoners, as against very ordinary day laborers. That comparison is fair to both the prisoners and to the day laborer, but would vary if all our prisoners were worked.

Now, as to the county prisoners: Wherever there are six or more prisoners in the county jails, we have them at work. These are worked by the county engineer or county authorities, and the only additional expense, so far as these men are concerned, is that of guarding. A jailer costs 10 cts. a day extra when these men work. He gets 50 cts. a day for the board and keeping of these men when they are not working or when they return to jail for dinner, and 60 cts. if they are working beyond the jail or where he has to send dinners out to them.

Since we have been tabulating the records, from June 1, we have been able to get out of our jail prisoners between 8,200 and 8,300 days' work a month. We can give you some idea of the value of our jail prisoners' labor. In one county, the authorities were not exactly opposed to prison labor, but they had some local people that opposed it, and the fellows wanting to make everything smooth and nice at home, tried to listen to that clamor. We asked time and time again to have the men put to work, and the same nice, smooth promise would come and the next day or next week, the same condition existed. Finally the department served notice on the county commissioners that we would give them 10 days in which to put those men to work or else we would apply for a mandamus and test the law. We received a very nice letter from the chairman of the board of commissioners, saying they were making arrangements to put the men to work. Six weeks after the men were put to work the sheriff of the county in making his report said he would like us to see what these green men had accomplished. He said, "It has surprised all of us, and I want to

say to you now that prison labor in this county has come to stay."

Now the advantage of working a jail prisoner we find is this: Many and many a fellow who will commit a small crime for the purpose of getting a short term in jail shuns the idea of getting out and putting in that many days at work. This has had the salient effect of reducing the repeaters, as you might call them, in the county jail. Not only that, but this class of citizens has been materially benefited, and a number of fellows that prior to our establishing this law were constantly getting in jail, after one period of county road work went right out and settled down and are making good and useful citizens. Those who had been the street bums prior to that time are now working.

The advantage, gentlemen, as I see it, in prison labor, is not so much the great saving that we are going to get from it, but the saving in reducing the desire on behalf of a certain class of fellows to be a charge upon the public for minor crimes. The making of these men better citizens so they will be self-supporting and producers instead of idle consumers, is the biggest gain that we are going to get. So far as the comparative value of prison labor and day labor is concerned, after the cost of guarding and everything is summed up, I believe that there will be but little saving except the benefit direct to the prisoner and to society. And if we can do this, gentlemen, I think and feel satisfied that the whole proposition is worth the effort, because after all is said and done, what have we done for the benefit of mankind, what has our government done to make better the generation in which we live and make stronger the chances for better men in the generation that is to follow? If we can reduce the desire for crime, that is the desire to be idle loafers, by making the right impression upon the boy that falls in wrong, by letting him know that he must work, and by the sweat of his face he must exist, we have accomplished about all that we can hope to get out of the prison labor problem.

Then, gentlemen, I would say first, let the prisoner help to build the roads, construct them by his labor so that he may realize that society is not indebted to him, but he is indebted to society, and that when the roads are constructed that the development of the roads will raise the standard of citizenship, and in raising the standard of citizenship in all our communities we will lessen the cause for crime and therefor benefit humanity in general. Thank you, gentlemen. (Applause.)

CHAIRMAN CROSBY: I am sure we all appreciate very much Mr. Williams' remarks, and especially his attitude on this question, and I am sure we have gained by our failures. We all care really more for our failures than our successes. In that connection it might not be inappropriate to point out that which Mr. Williams spoke of, that after the season was ended a record came into the office showing a loss at one camp considerably greater than there was at the others. Now, without meaning to suggest that there was any failure on Mr. Williams' part it will be recognized, I think, if the Chair suggests that had such a system prevailed as would have indicated that loss as about to occur, rather than having occurred, it would have been of considerable advantage to the department.

The next speaker on this subject on the list is Mr. Bowlby. Mr. Bowlby, the State Highway Engineer of Oregon. Is Mr. Bowlby here?

Is Mr. Buffum, State Highway Commissioner of Missouri, here?

Mr. Kerr, Assistant Engineer of the Louisiana State Highway Department is here, or has been here. Mr. Kerr of Louisiana.

CHAS. M. KERR (Assistant Engineer, Louisiana State Highway Department): After having heard Mr. Ehrhart's paper upon the fitness of convict labor for road construction, I feel that there is hardly anything further to be brought forward upon the subject, as he has so ably covered the ground. Anyone having had experience with labor of this sort, and who can appreciate the value of it, and has the welfare of the prisoner, from a humane standpoint, at heart, will readily agree with his views.

Just as truly as there have been crime and criminals since the beginning of time, so, no doubt, it will be for all time to come, and the scientific handling of those unfortunates who come under the ban of the law will mark a great stride in the right direction in the progress of civilization.

There is no just reason to believe that because a human being has broken the law governing society he is necessarily a permanent menace to it, and should therefore be treated as an outcast and given no opportunity to repent of his wrong-doing, and no chance to come back and make good, thereby re-establishing his claims to citizenship, and the respect of his fellowmen. Many a crime is committed in the heat of passion, or under circumstances in which the offender has otherwise momentarily lost control of himself, circum-

stances that may happen but once in a lifetime, and it is decidedly unfair to turn against one so unfortunate and not give him a chance to pay his debt to his state and community in such a way that at the expiration of his term, shortened by good behavior, he will be able, if given the opportunity, to resume his former position and good standing in society. For this reason, the penal institutions of our country should not be places where punishment is meted out to offenders without regard to the moral effect upon the prisoners themselves, by inflicting indignities and unnecesary hardships and privations upon them. These institutions should have a tendency to exert a good influence, and to pursue a corrective and educational policy in regard to those convicted of crime, so that when one has served his time and is discharged he may leave the penitentiary a better man than when he entered it.

It is useless to dwell upon the evils of the contract system, and the necessity of abolishing this relic of barbarism from our prisons. No private individual or corporation has the right to make use of and profit by the misfortune of the state prisoners, especially as under such a system the lot of the convict is often worse than slavery in its worst forms. When anyone has broken the law and is convicted, he owes a debt to his state which he should be made to pay in a way profitable only to his state and himself, since he is an item of expense to the community. And in my opinion, there is no system whereby more good can be accomplished to all concerned than the employment of all able-bodied male prisoners upon the improvement and construction of good roads.

It would be next to impossible to have fixed rules and regulations governing the details under which convicts should labor in all sections of our country. A system that may work satisfactorily in one state may not do at all in another, and so the general methods of the management of convicts in road construction are necessarily governed by local conditions. For example, the great majority of convicts in my state are negroes, and experience with the average convict of this class firmly establishes the fact that the "honor system" would be a dismal failure if put to the test in the true sense of the word. However, when a prisoner shows that trust can be placed in him, his position is not far different from what it would be if the "honor system" were in actual practice with us. As we in Louisiana have successfully demonstrated the efficiency of convict labor in the construction of many miles of highways, I will give you a short resumé of the system as practiced by us:

When the Highway Department of the State of Louisiana first came into official being, upon the morning of February 6, 1911, little had been previously done by the state to further the cause of good roads. In fact, previous to the year 1909, rural road effort in Louisiana was mostly confined to spasmodic spurts of energy on the part of individuals, parochial authorities, communities and others, each on its own responsibility and each in its own peculiar way, with limited means, striving simply to accomplish something somewhat more advanced than Nature had already vouchsafed them.

In this year, under a broad proposition advanced by the Governor of the state, in the absence of state organization, an understanding was reached by which the state should furnish the services of the Board of State Engineers for all engineering work, and the forces of the State Penitentiary for construction work; the police juries of the parishes should furnish funds for the actual expenses incident to same, and the United States should furnish superintendence along model lines. This resulted in many excellent road projects being proposed and executed during the following year—so much so, that, at the session of the General Assembly of the state in 1910, a law was passed requiring the Board of State Engineers to assume, under certain conditions, control of the highways of the state; to employ a highway engineer; to define his powers and duties and fix his compensation; to authorize the construction and maintenance of highways by contract or by the Highway Engineer; to provide, under certain regulations, for the working of convicts on highways; to authorize, by expropriation or otherwise, the acquisition of right of way for highways, drainage canals or ditches, to provide revenue for carrying out the objects and purposes of the law, and for the disbursement thereof; to require the parishes, cities, towns and villages to contribute a certain proportion of the cost of construction and maintenance; and definitely defining the meaning of the name, "state highway."

One of the most valuable provisions of the law soon developed in the fact that the state's convicts could be utilized upon its highways, enabling the consideration of projects otherwise, by reason of inadequate means, practically prohibitive; it being demonstrated, that when properly organized, equipped, directed and handled, such forces offer the most direct, systematic and economical method by which to arrive at comprehensive results.

Unfortunately, the life of the demonstration was, from causes over which there was no control, of only a short duration.

Other works of public improvement upon the construction and maintenance of which the state was immediately more vitally concerned demanded the withdrawal, for at least the time being, of the convict forces from highway work.

Particular reference is had to the construction and maintenance of the public levees of the state which, by reason of two successive periods of extreme high water in the Valley, entailing more readjustment than usual, had to be given precedence over all else.

Therefore, at present, all work in progress by the Highway Department is being prosecuted under contracts or by force account, and while of course, the standard of efficiency is in every respect maintained, the funds so far available to the Highway Department of necessity cannot reach as far nor accomplish as much by possibly as much as one-half that which would be possible with convict labor under the conditions already outlined herein.

When the demand for convict labor in the other fields described becomes less exacting and imperative, it is hoped that the Highway Department may again enjoy the benefits of its services, thereby again permitting this form of aid to the parishes of the state, and the great benefits to be thereby derived.

Whether the aid extended by the state be monetary, or through its convict forces at actual cost, the first step to be taken by any parish desiring state aid is to make application to the State Highway Department therefor, upon forms specially prepared for the purpose. This application must be supported by a resolution duly passed by the police jury of the parish, setting forth its financial status and ability to meet its obligations, and binding itself to abide by all the requirements prescribed by the Highway Department. Having, through the Highway Department, secured the services of a convict force, the parish is required to promptly supply a suitable camping outfit, including living quarters, and a complete equipment adapted to road building.

In the employment of convict labor, the first outlays are generally the most extensive, involving as they do the preparation for its care, which should be the best, and the equipment, which should be the most modern and up to date. This, however, may with equal justice be said in regard to any class of labor, whether it be free or otherwise. Undoubtedly, the best returns can be looked for only in conjunction with proper consideration and proper treatment. The closest attention to the quarters of the men, and to their upkeep, is imperative, while all sanitary measures and hy-

gienic requirements shall be strictly followed and observed, medical services being supplied by a local physician who is especially employed and retained to look after the health of the men.

Again, a convict force, to give the best results, must work as a unit with a governing head. To fill this position requires special experience in dealing with this class of labor, and, in selecting anyone for the position, due regard should be had as to whether or not the person selected be a good judge of human nature. The man selected for such a position is generally known and styled as the "captain" of the force. He must be a strict, yet just, disciplinarian, whose business it must be to preserve order, govern the men, see to it that everything runs smoothly, and that efficient service is obtained. A captain has under him a sufficient number of foremen and guards, the duty of the foremen being to direct the men while at work, while the duty of the guards is to preserve order and prevent the escape of any one disposed to attempt it.

By far the greatest percentage of convicts in Louisiana consists of negroes, who, when properly governed and directed, rank second to none as laborers. Some who may recognize the error of their ways, and, by good behavior have won the confidence of the authorities, become what are termed "trusties," and are allowed considerable latitude. Unfortunately, however, there is always, as well, the incorrigible, who, under the name of "gunman" is constantly kept under close and strict surveillance.

From the foregoing, it will be seen that in the government of a convict force, power is vested in one head, with all necessary aids and assistants.

The housing, clothing, feeding and general maintenance of a convict force is in itself a problem. Suitable quarters must be supplied for the captain, assistants and guards, while off duty, and a sanitary, well ventilated cell-house, large enough to accommodate the full force of convicts is absolutely necessary. While the captain, assistants and guards can ordinarily be cared for in tents, an inclosure of a more substantial character must be provided for the other quarters. The latter structure will largely depend upon circumstances. The moving of camps is a very important item, and generally a comparative costly one, especially if the nature of the work in hand requires rapid movement or progress, such as simply repairing improved highways, or the construction of the simplest class of roadways, where the constant change of camp is necessary to insure reach

without too great loss of time. In such cases, in fact, convict quarters should be as light in structure as practicable, and easy to erect. Where permissible, in lieu of one large cell-house, several smaller compartments should be substituted, placed upon trucks so that they may be easily and quickly moved from place to place, materially reducing cost. After living quarters have been fully supplied, attention should be directed to the necessary accessories of camp life, such as a covered dining room, for use especially in bad weather; then a complete commissary, with a competent clerk in charge, usually a white convict, and a well-furnished kitchen. All of the latter can be housed in tents.

In regard to the equipment for actual road work, besides all necessary implements and tools for handling earthwork, clearing right of way, building bridges and culverts of all kinds, the purchase of which brings the initial outlay to quite a sum, a sufficient number of live stock should be added. A camp of 50 laborers should have at least ten teams, which means an expenditure, at the very outset, of at least $5,000. None but the very best of stock should be considered, slip and wheeler work requiring large, heavy animals. For the care of this live stock, still further camp equipment, in the form of stables, barns, and the necessary fencing for a corral, is necessary. With one more addition, a practically equipped blacksmith shop, a camp may be rated as complete and prepared to accomplish efficient and economical work, provided all departments interested act in unison and harmony.

Under the methods in practice in Louisiana, the Board of Control of the State Penitentiary, the police jury of the parish interested, and the Highway Department—three in number—are the departments to which reference is made.

The duty of the first is to furnish the labor, with captains, assistants and guards of its own selection, the captain constituting the representative of the board on the ground.

The duty of the captain is to handle the labor in all its details, and to direct all routine work attached to the camp.

The duty of the police jury, after equipping a camp in full, is to supply all funds necessary to keep the camp going, and to furnish all bridge and culvert material, or any other incidentals that may be needed.

The Highway Department should establish all locations, formulate all plans and specifications, and have entire charge of the actual road construction, including all details connected therewith, under a resident engineer, who, under the direction and supervision of the State Highway Engineer should make all necessary surveys in connection with the

location of a highway, and have direct charge of all operations in the field, the captain being under him and required to carry out all orders emanating from him.

With the foregoing described system in operation, and everyone interested working for a common cause, an important problem, I think, may be claimed to have been solved.

Lack of sufficient funds with which to carry on the work of constructing improved, if not model, highways, on a proper scale, is the greatest obstacle in the path of the good roads movement in Louisiana. If a system, whereby the cost can be reduced to a minimum, and the contractor's profit eliminated, can be ever introduced and maintained, the highest standards may yet be lived up to and a tremendous stride made along ambitious lines. To me, this is rendered possible by convict labor.

With this labor, one has at his command, well fed, well clothed, healthy, able-bodied men, on hand at all times, and to be depended upon for value due in vast contrast to the shiftless, ill nourished, undependable free negro labor upon which contractors in Louisiana must of necessity mostly depend.

In Louisiana, about 175 miles of improved highways have been so far constructed with convict labor. Except for about 12 miles of gravel road, all of the work thus done has consisted of earth and sand-clay roads. The saving through this form of labor and expenditure, as compared with similar work performed by contract, has ranged from 40 to 60 per cent. Had these highways been of a higher class of construction, thus not necessitating such constant moving of camps, it is firmly believed that a still greater saving might have been effected. As it is, earth and sand-clay roads have been constructed under the system current in Louisiana, at from $750 to $1,000 per mile, while the graveled surfaced roads cost on an average of $4,000 per mile.

From actual experience, it has been ascertained that the cost of maintaining and operating one convict per year in Louisiana, is about $170, or between 45 and 50 cents per day.

Besides giving the convict the benefit of good, healthy outdoor exercise, he can make himself so proficient in one or more details of highway construction, that at the expiration of his term, he is able to find employment with little difficulty, as the movement of highway improvement is steadily gaining headway, and there is a constantly increasing demand for skilled labor.

It would thus appear that every inducement to further the use of state convict labor upon the highways of the state

were held out, and it is greatly to be deplored that the opportunity to demonstrate beyond cavil its great value proved so short-lived.

A camp of 50 men should be allowed the following superiors:

1 captain, at $75.00 per month	$ 75.00
3 foremen, at $40.00 per month	120.00
5 guards, at $30.00 per month	150.00
Total	$345.00

An approximate estimate of the cost of equipping and running, for road purposes, a convict camp, based upon a force of laborers numbering 50, would be as follows:

10 teams, at $500.00	$5,000.00
10 road slips, at $7.00	70.00
1 road grading machine	200.00
1 road roller	2,000.00
2 road drags, at $20.00	40.00
1 blacksmith outfit	50.00
All necessary axes, picks, shovels, etc.	100.00
Tents for living quarters, dining room, stables, etc.	500.00
Kitchen outfit	50.00
Lumber for cell-house, etc.	500.00
Incidentals	500.00
Total	$9,010.00

CHAIRMAN CROSBY: Gentlemen, I think you will all agree with me when I say that down in Dixie we consider Mr. Kerr as one of our live wires, an exemplification of the old adage that good things do come done up in small packages, sometimes. The papers on this subject have been very interesting, I am sure. The next man on the program who is listed to discuss the subject has been unable to come, Dr. Pratt, much to our regret, and the subject is now therefore before the convention for discussion. Is there any one on the floor who would like to offer any remarks or ask any questions?

W. M. BRYANT (Chairman, Board of County Commissioners, Kalamazoo County, Mich.): The gentleman from West Virginia in his estimates of costs, figures in the total amount of camp equipment and things of that sort. Now that, I suppose, is just for one year, for the first season, that the camp equipment could be used. I should think the equipment would be in good condition to use a second year and therefore would cut the cost.

MR. WILLIAMS: I gave the figures just as they came to me from the state prison and charged to the work. In the first place, the greater percentage of that camp equipment, being ordinary style tents, would deteriorate 50 per cent. a year, and you could not figure on your tents being good for more than two years, which would probably cut the cost in half. I want to ask a question here. I see Mr. Scott of

Virginia, here. Mr. Coleman, in his paper, stated the cost of guarding and clothing and feeding and maintaining the prisoners is between 51 and 52 cts. per day, if my memory serves me right. Mr. Kerr states that the cost of his prisoners is between 45 and 50 cts. per day. My experience from handling camps, especially camps for several years when I was associated with them, shows that the actual cost per man to feed him and feed him right, ranged between 51 and 57 cts. per day. Now, I want to raise a little question as to the amount, in other words, the class of food we give these men. I am asking for information to try to get at the bottom because we are here for the purpose of getting the most efficient method of handling the men, and I would like to know the style of food that you give them.

C. B. SCOTT (Assistant State Highway Commissioner of Virginia): Mr. Chairman, and Gentlemen: In Virginia we have 30 camps of prisoners, averaging from 50 to 55 men each, giving us about 1,500 to 1,700 prisoners on the work depending upon the season. Now, in West Virginia, I have also had opportunity to go to their lumber camps and see how men are fed there. I have taken meals at the lumber camps, and I must say the lumbermen in West Virginia are very well fed. They have quite a variety of fresh beef, fresh vegetables of all kinds, canned fruit of the best kind, peaches, and so forth, and pie, and things of that sort. In other words, they have very good fare. Now, the prisoners in Virginia are not fed on the same plane with the lumbermen in West Virginia. They give them plain, wholesome food, but they are not fed on the same plane, and the cost is a great deal less. Now, it is probably a fact that we get some help in Virginia from our penitentiary in the way of clothing. All the prisoners in Virginia are not in the convict force. There are about 500 of the men, and all of the women in the penitentiary at Richmond, and the clothing for the men in the convict force is manufactured at the penitentiary at a very low cost and in that way the cost is reduced. The cost in general, as Mr. Williams says, is about 52 cts. per day. That includes building the camps, clothing, guarding and feeding the prisoners.

Now, I would like to ask if there is any one here who has experience in prison labor on county highways where they pay the prisoners something for the work they do? I understand in some states the prisoners are paid so much per day for the work they do, or else they pay them a lump sum when they leave the prison camp. I would be glad if any one can give us any information about that.

MR. BRYANT: We have used our labor largely during the spring, summer and early fall. During the winter we have a plant about six miles out of the city where we make tile for roadwork and sell considerable to the surrounding country. We expect to go into brick making, and, in fact, within two years we expect to use every prisoner during the summer. We have from 10 to 40 prisoners per county. In the winter we have from 60 to 75. The men are paid to behave themselves, and it is the exception when they do not. Out of all the men I have only taken three back to the jail. We pay them 20 cts. a day for good behavior and good work. The men are all earning as much as any ordinary man. With the possible exception of the two or three, they are earning $2 a day. They are costing us about 75 cts. a day. In Michigan we are making better citizens of them, although the old offenders are repeaters. With us, it is largely a case of drink. Alcoholism, wife desertion, and a few other things are where we get the main portion of our prisoners. The majority of them are white, so we do not have the same questions to work out which Mr. Kerr has so ably described in Louisiana. We have the honor system entirely; we have no guard whatever. I have at the present time quite a number of them working out and they are boarding in farm houses. In one place we have wagons which are used during the summer for the superintendents, and a place is made for them to sleep and keep their records. We have several of these wagons distributed around the county and prisoners will sleep in those. We do not feel like going to private families, but in a good many places they are eating at farmers' tables all through the summer. We have a system of camps. A man and his wife help out with the work of the camp. The man is a teamster, for instance, and the wife does the cooking, and gets the victuals for the table. The superintendent has complete charge of the whole number of convicts. We mix in both convict labor and free labor. We find in a good many instances that is a good thing. It is an inspiration on both sides. A little talk to the prisoners as they go out to work will help them and the other fellows are compelled to keep up their end of the program.

MR. WILLIAMS: Mr. Chairman, I want to add just a thought on that. Our experience in working the free labor with the convict labor has been directly the opposite of that. The free laborer rather feels that he should do the easier work and shove the harder work on the convict. The convict feels that he has already got the worst end of the deal because he is already convicted, and he feels he is get-

ting the worst treatment, and it results in dissatisfaction and with us it works wrong. We have all classes of labor to deal with. We have colored men, and we get quite a number of foreigners. The hardest man that we have had to contend with so far from the standpoint of trying to escape is the Italian. The greater percentage of our attempts to escape have been among Italians, especially the Sicilians. I have just glanced at the report of Camp No. 1, and I notice the amount of beef consumed at the prison camp is an average of four-tenths of a pound per day. It is our experience, or rather the feeling of those of us that have dealings with prison labor, who also have dealt with other labor, that the better you feed a man, the better results you get from him. Now, we pay our prisoners all the extra time they make over nine hours per day at the rate of 75 cts. a day for all overtime. Nine hours is the length of day provided for in the state law f~ ll state employes, and the prisoners come under that same . We could not work them any longer, but by agreement—it is a gentleman's agreement between the prisoner and the county, so to speak—he gets extra pay for the overtime work. That is especially where they act as watchmen or blacksmiths. and they sometimes make considerable extra. We have one steam shovel which is operated by one of the prisoners. He is a man that had experience before he got into prison. When he found he could get that position outside, he made a petition that he might operate the steam shovel, and he has been a very valuable man out there. He was not a real criminal, but a man who committed a crime in the heat of passion. He wants to rise.

MR. SCOTT: But you consider your convict labor is a success?

MR. WILLIAMS: Certainly, I do, and as I said a while ago, it is a success in a good many ways. Now, take McDowell County, which joins Virginia in the southern part of the state. We have five county prison camps there. I want to state for the benefit of those who are questioning my figures that we work all of our county prisoners, and we work them under guard, and some of those we work in shackles; that is, we make what we call a leg-pick. It is like the ordinary pick, except it is made light. The prisoners themselves make it in the road blacksmith shop. That pick is fastened around the ankle with a lock and when running the pick catches in the ground, or it picks the prisoner in the back of his heels. We do not put out all our county prisoners on honor, except, as Mr. Kerr says, where we can do it safely and the man shows that he is capable of being

on the honor system. At night, instead of sleeping them in cages, we have a leg chain that we fasten with a clasp around the ankle. One long chain extends the full length of the bunks. The long chain is fastened with a lock at each end of the car so in case of fire the chain can be unlocked. We do not use prisoners as watchmen or guards. We find that that is not a success because of the jealousy existing between the prisoners themselves.

MR. SCOTT: Mr. Williams, don't you think it is quite an advantage to have prison labor in the fact that you have a steady force, and you know just what you are going to have from day to day?

MR. WILLIAMS: That is the great advantage. You have got a steady force, and as Mr. Kerr says, of well-fed men. I made a comparison a little while ago, and I do not want it to be said I was comparing the efficiency of prison labor as against free labor, more than the fact that the better class of free labor is not obtainable for road work. I don't think that a well-fed free laborer going out to work on the road will do less than a prisoner. The average men that we get on the road will not do as good a day's work as the prisoners, but you do not often get the better class of laborers for road work.

CHAIRMAN CROSBY: I would like to announce, and am requested to announce that the management of the convention desires quite naturally to secure the utmost possible registration. We want the names and addresses of those who are interested enough to come to Chicago and to attend this convention. Opportunity for registration has been provided downstairs, and probably most of us have registered there, but I am convinced that some have neglected, or escaped the registration officers. I would like to ask that you do us the favor to see that your name and address are registered before you leave the city. If you will kindly remain and do it when you go out, so much the better, but if you don't register before you get to the hotel, won't you be good enough to hand your name and address in at the headquarters on the second floor before you go away?

MR. SCOTT: How many have registered?

CHAIRMAN CROSBY: The report of the Credentials Committee which will give the number registered, will be turned in at the business meeting which will follow this discussion. I think there are approximately 3,500, but I believe there are more; I have just been told that there are nearly 4,000, which I think is a record breaker.

Now, we are all greatly interested in this subject. I have had some experience with convict labor, although very small in comparison with these other gentlemen, and I know we could, with interest and profit, go into the details of this subject to a considerable extent, but there are others here who are interested in some other subject, and we must give them a chance.

DR. JOSEPH HYDE PRATT* (State Geologist and Engineer of North Carolina): I have had an opportunity to read an advance copy of Mr. Ehrhart's paper on "Convict Labor in Road Construction." I have found his paper extremely interesting and I am in hearty accord with nearly all the suggestions and statements that he has made.

He raises the question as to whether confining convicts is only a punishment and for the purpose of simply protecting the public from further crimes on their part, or whether they are sentenced and deprived of their liberty and confined, with, at the same time, the hope that during their period of imprisonment their treatment will be such that it will work a change in their moral nature which will have a tendency to improve their characters.

In commenting upon this point I wish to lay stress upon certain facts which I believe are fundamental in regard to our treatment of convicts:

First. The convict is a human being and must be treated as such; he has a sense of responsibility, honor and discipline, and this sense can be quickened and developed.

Second. Perhaps with few exceptions, there is some good in every convict, which can be developed and made paramount in the character of the man.

Third. The convict in serving his sentence is simply paying a debt that he owes to the state for certain infringements of the laws of that state; and, when he has served this sentence, he has paid his debt and should be in a position to become a good and valuable citizen of the state. Most convicts are serving a first sentence and often for a crime committed on the spur of the moment, and with many of them this one crime committed represents the only black spot in their lives.

Fourth. Hard work is a good reformer, and idleness begets melancholia.

Fifth. The state, on her part, owes it to the convict to assist him in every way to pay his debt as speedily and eco-

*Written discussion submitted but not read at the convention.

nomically as possible, and in such a way that he is a better man when his debt is paid than when he was convicted.

Sixth. The attitude of the state toward the convict should be corrective and not vindictive; to uplift and not degrade him.

Seventh. To put a man in stripes often so degrades and humiliates him that it is extremely hard, and sometimes impossible for him to reform.

Eighth. Outdoor work is much more conducive to good health and cheerful dispositions than confinement in prisons or factories with no outdoor exercise but what can be obtained in the limited area of a penitentiary yard or court.

Ninth. There must be an incentive before good work can be expected from most convicts.

Tenth. There is a great variation in the character and working ability of different convicts.

Eleventh. In many cases families were dependent upon the convict before his sentence and are, during his incarceration, deprived of that support.

I believe if those who have authority over our convicts would be governed by these facts, there would be a decided change in the general attitude of prison officials and others in authority over convicts, and that in the end a large majority of our men serving terms of imprisonment would leave the prisons better men than when they entered, and in a much better frame of mind toward society in general.

I will go further than Mr. Ehrhart in regard to the employment of our convicts in the construction of public roads, as it is my belief that not only the honor men can be worked in this way, but that all able-bodied men can be worked to advantage on the public roads, even if they have to be guarded. I am heartily in accord with his statement that the contracting of the labor of convicts to individuals is one of the worst arrangements that could be devised, and it has not only a terribly bad effect upon the men, but is a disgrace to any state that uses it.

I am heartily in accord with the idea that the men should be allowed a certain commutation of time for good behavior and good work, and in North Carolina the men are allowed at least five days per month. I also believe that the men should be allowed a certain per cent. of the value of the time that they are obliged to work for the state, the money thus earned to become accumulative and to be turned over to them at the expiration of their sentence, or to be turned over to their families if the families have been dependent upon them for support. If the family is not in want, the money

accruing to the credit of the convict shall only be turned over to the family at his request, and then there should at all times be a certain percentage of that amount kept to his credit in the penitentiary treasury. I believe that being able to actually earn a certain amount of money will be an incentive for the men to do better work and to try harder to live up to the rules and regulations of the penitentiary.

In Colorado where 300 convicts (honor men) are employed in road construction, they represent about 30 per cent. of the prisoners. There are in North Carolina about 2,100 convicts working the roads, which is about 75 per cent. of the total number of convicts in the state. In Georgia there are nearly 5,000 working on the public roads, which is approximately 95 per cent. of the total number of convicts. Of course, the cost of working convicts that have to be guarded is considerably greater than where they can be worked in honor camps, but, nevertheness, I am of the opinion that just as many of the convicts as possible should be worked on the public roads, and to this end it is my idea that convicts should be divided into three classes, as follows:

Those in the first class, who would not be required to wear startling or very noticeable uniforms; those in the second class, who would be required to wear a distinctive uniform but not stripes; and those in the third class who would be required to wear stripes, and, if necessary, have their heads shaved.

To the third class would be assigned those who had been convicted and sentenced more than once for some crime against the state, and also those who, while serving out their sentences constantly broke rules and regulations of the prison authorities.

To the second class would be assigned those who had started in the first class but had shown that they would not obey all the rules and regulations or do good or efficient work and were not to be trusted; and, for further infringement of the rules and regulations, they would be assigned to the third class. To this second class would come men from the third class, who had shown by their work and their deportment that they were trying to live up to the rules and regulations and become better men. They in time might be transferred to the first class.

To the first class would be assigned those who had been convicted for the first time, and they would remain in this class until they had shown by their behavior that they were

not to be trusted or would not do good and efficient work, when they would be assigned to the second class. In this first class would be men who would be known as "honor men."

The organization of this convict labor for road construction would be of two distinct methods, depending upon the classes of convicts used: First, would be the convicts that could be worked without guards and without stripes, representing the men of the first class or "honor men." Second, would be those over whom it was necessary to have armed guards while they were working, and would be convicts of the second and third classes.

The men of the third class would wear stripes and work under guards with guns, and the worst men of this class might have to be worked in stockades in breaking rock or doing similar work. Those of the second class would be worked under guards with or without exposed firearms, as the case might be. At night the convicts of the third class would be in chains and under guards, while those of the second class would not be in chains but under armed guards.

The convicts which I have suggested as the first class, or "honor men," would correspond to the 300 convicts that are now being worked by the state of Colorado on its roads. I am in accord with the suggestions of Mr. Ehrhart that the camps prepared for this class of men would be very similar to any camp where the work was being done by free labor. I believe that long term men can be worked in honor camps just as well as short term men or men whose sentences are almost completed. I believe one of the stronger motives that will influence the men in the first class, or "honor camps," is the fact that confidence has been placed in them and that they are trusted by the officials. It must, however, be realized by those who undertake the work of the convicts in "honor camps" that *"honor men" must be "honor men" in every sense of the world.* There must be no guards of any sort.

In the second method of organization which I have suggested, where it would be necessary to have the convicts guarded, we would have two classes of convicts, one of which, the second class, had shown, for the time being, at least, that they could not be trusted in any way and had to be worked in stripes under armed guards and had to be chained at night.

Class II would also have to be worked under guards, but it would be found that in some instances, as will be noted later, it would not be necessary that those guards carry ex-

posed firearms. The men of Class II could be divided into two groups. Those of group 1 would be considered men who were on probation before being transferred to Class I; and, while they would still be worked under guards, it would not be necessary for those guards to carry exposed firearms. Group 2 would be worked under guards carrying exposed firearms, but without chains. At night all the men of Class II would be in camp under armed guards. Those of group 1 would not be on a chain, while those of group 2 would be. These men of Class II would wear some distinctive uniform, but not stripes. The men of Class II should be allowed a certain percentage in money of the value of their labor, which, however, would be one-third less than that received by the men of Class I, and there would be no bonuses allowed for any extra work. The men in group 1 of Class II would have the advantages over group 2 of not being under guards with exposed firearms, not being on the chain at night and being in direct line for transfer to Class 1. This, I believe, would be incentive enough to keep these men from breaking rules and regulations of the camp. Group 2 of Class II would know that by good behavior and good work they would be able to get transferred to group 1 of the same Class, and in the end to Class I.

For infringements of the rules and regulations, and for any attempt to escape, they would be punished similarly as stated for the men of Class I.

The men of Class III would be divided into two groups. Group 1 would be worked on the public roads but under guards, and, if necessary, with chains. At night they would be under strict armed guards and on the chain. Those of group 2 would be men whom it was not considered advisable to work on the public roads, and would be worked in stockades under armed guards, and, if necessary, with ball and chain. Those men could break rock for macadam, make cement drain tile, or other work that could be done in a stockade. With good behavior, the men of Class III would be transferred from group 2 to group 1, and then from group 1 to Class II and so on to Class I. They would also be allowed for good behavior a commutation of their time and a certain per cent. of the value of their labor in money. This, however, would be considerably less than that received by the men in Class II.

The one idea embodied in the above suggestions is that the rules and regulations of the camp and penitentiary authorities must be obeyed, but in obeying these the convict becomes entitled to receive special consideration by the state.

It is not economy to work convicts on the roads in small camps, as the overhead charges are too great. Where a camp is to be established, 30 men should be a minimum, and it would be better to have at least 50 men in a camp.

The importance of having satisfactory and sufficient tools and machinery for doing the work should be emphasized, but greater emphasis should be given in regard to the character and experience of the men who are to have charge of the convict camp and supervise the labor of the men. Only men of good character should be in charge of the convicts, and the men in charge of the work should be competent road engineers and builders.

I believe that if the above suggestions are carried out, we will find not only a satisfactory method of employment for "honor men," but also for all convicts.

CHAIRMAN CROSBY: There is one other subject on the program, that of "Dust Prevention and Street Cleaning," and unless there is some serious objection or some important point to be brought up of general interest on the question of convict labor, I will call for the speaker on the next subject. The subject was assigned to Mr. Chas. O. Davis, Superintendent of Street Cleaning, of Milwaukee. He was unable to attend the afternoon session, and I will therefore ask Mr. Wm. H. Connell, Chief of the Bureau of Highways and Street Cleaning, of Philadelphia, to present a few facts in the matter. Mr. Connell has had considerable experience in the third largest city of the country and is entirely competent, and I am sure you will agree with me when you have heard him.

Dust Prevention and Street Cleaning*

By WILLIAM H. CONNELL
Chief, Bureau of Highways and Street Cleaning, Philadelphia, Pa.

I am in the same position that the rest of you are—prepared to listen to a paper on this subject and to discuss the paper. As a matter of fact, I didn't write anything, but was going to discuss the paper itself, as presented. I was informed by Mr. Powers at the close of the morning session that Mr. Davis couldn't get here and hadn't written a paper, and asked if I would open this subject. I will just

*Remarks by Mr. Connell in place of Charles O. Davis, Superintendent of Street Cleaning, Milwaukee, Wis., who was scheduled to present a formal paper, but was unable to be present.

outline a few elementary points and hope to open the subject for discussion.

The title of the paper is "Dust Prevention and Street Cleaning," which, of course, is a very broad subject, but it is an important one. While street cleaning has been included with dust preventives for the first time, it is logical that they should be discussed together, as one of the main problems of street cleaning is dust prevention. We have had papers on dust prevention, but we have never combined dust prevention and street cleaning, and they are so closely related that it is a step forward to make the title of the paper "Dust Prevention and Street Cleaning."

I will first take up the dust layers, and that leads us into the bituminous surface treatments. In defining dust layers, I refer to the lighter oils and other materials which are supposed simply to lay the dust. Water, of course, is included in these materials. The bituminous surface treatments are dust preventives, because, properly applied to the type of road suited to that character of treatment, they make a more or less dustless road.

The practice I have followed in connection with dust layers is to apply about 2 gal. of 19 to 23 Be. gravity asphaltic oil per sq. yd., the object being just to have this material lay the dust as long as it lasts and then disappear from the road. If it goes into the road, this character of material tends to disintegrate the road. This method of treatment costs in Philadelphia $0.0113 per sq. yd. for each treatment, which does not include any covering.

The number of treatments depends on the traffic conditions. Roads carrying a normal amount of traffic, such as you have in the suburban sections of the city, and the more or less heavily traveled country roads, will require one treatment early in the spring, say in May, or as early as you can get it on, depending on the climatic conditions, and another treatment later on in the season, about August. The second treatment will disappear from the road in the latter part of November, and you will have a normal road surface to go through the winter. This does away with the mushy condition which we all experienced in the early days when we put on heavy applications of oil to lay the dust, and they remained on the roads throughout the winter. I am not going to name all the materials that can be used, because they have been more or less standardized. Of course, we have oils from a number of different manufacturers, and all of them—or practically all—have their place

in this method of treatment. We have also calcium chloride and other products which are intended to lay the dust.

The bituminous surface treatment, which I term as a dust preventive, should be applied on water bound macadam roads that are in good repair. In this class of work we have different methods of treatment; we have the lighter materials, such as refined coal tar (Tarvia B) and refined water gas tar (Ugite B), which materials can be applied cold. The first treatment requires about ½ gal. per sq. yd., covered with 15 lbs. of chips or fine washed gravel. In connection with this I might say that I was rather looking forward to what Mr. Davis was going to say, as I understand he has been using slag screenings for his covering. I have no reason to believe that slag screenings will not answer the purpose just as well as trap rock chips, and in a community where they are available, of course, they would be cheaper. This treatment carries through the season, except on some heavily traveled roads, where, in a few cases, it is necessary to apply an extra treatment during the first season. The second treatment averages about ⅓ gal. per sq. yd., with about the same amount of chips or gravel as in the first treatment. The idea of putting on a small amount of covering is simply to protect the treatment so that it will not be taken up on the tires of vehicles before it is thoroughly set up and will not incorporate into the bituminous material and form a pad. I might say in the first place that the practice is to let the treatment remain about twelve hours before covering it and opening the street to traffic. The bituminous material is only to act as a seal coat like paint on steel or woodwork; and when it requires touching up, simply repaint it. This does away with the patching that is required where the pad method is used. Such patching is very difficult—in fact, so difficult that a number of localities have given up this method of treatment.

Another type of bituminous treatment should be selected where there is heavier travel, and for this purpose you would use a slightly heavier bituminous material, one that is applied hot, such as the heavier refined coal tar (Tarvia A) or refined water gas tar (Ugite No. 2), or an asphalt cut-back which is applied cold. The method of treating the road and spreading the chips, etc., is the same as with the lighter material. The asphalt cut-back is more or less new and probably needs some explanation. It was evolved from the tar treatment. The purpose was to get an asphalt that could be applied to the road and which had sufficient stability and was low enough in penetration at least to set up

and at the same time could be applied cold by a pressure distributor. I have been carrying on some experiments in that direction for the past four years. At present in Philadelphia we use about 65 per cent. of 100 to 125 penetration asphalt, and about 35 per cent. of a 50 to 54 commercial naphtha. They are thoroughly mixed and then applied to the road surface cold. The naphtha simply acts as a carrying agent and leaves a very light crust of asphaltic material on the road. The first treatment of this material requires about .4 gal. per sq. yd.; the second treatment should not be more than .2 gal. per sq. yd. I find that you don't require as much of the asphaltic cut-back as you do of tar for the second treatment, and there is danger, great danger, in applying too much. The tar sets up and becomes perfectly hard, more or less brittle, and there is very little tendency for it to push; the asphaltic material, however, is more or less resilient and elastic, through all seasons of the year, and is more apt to push under traffic, and for this reason it is desirable to apply just a film coat that will not push under traffic.

Bituminous surface treatments and dust layers are more or less standard for all classes of roads. First comes the dust layer for the earth roads, macadam roads, and all gravel roads that are not in condition for the better grade of bituminous treatments; second, the film coat (hot or cold application) for the roads that are in condition for the better class of bituminous treatments, which, if properly maintained, will last almost indefinitely. This statement isn't based on any mere conjecture or theory, but on fact. It has lasted in a number of localities in this country for seven or eight years and, I am informed, is a method of treatment that is largely used abroad. The asphaltic cut-back material has had four years' test. When the stone is very soft, the pad method will have to be used. These treatments, of course, are all dependent upon the amount and character of traffic. These bituminous surface treatments are not suitable where the traffic consists primarily of heavy loads carried on steel tires. A most important point is to put on the second application at the proper time. If, in the spring, the road requires a treatment and you neglect it for about a month, it will result in the road rutting and will require extensive patching or resurfacing. The patching that is ordinarily required with this method of treatment is very slight, it being necessary only to paint the surface and throw on some chips. You should not put on an excess of material; this is apt to make the patch

higher than the adjoining surface of the road. It is a simple method of patching. I believe in Chicago and vicinity you have soft limestone, which, if too soft, would not be suitable for a film coat treatment, in which case it would probably be desirable to adopt the pad method of treatment; however, in the Eastern States there is plenty of stone hard enough for the lighter superficial or film coat method of treatment.

The accompanying table was presented in a paper which I read before the Franklin Institute, Philadelphia, and gives the cost of bituminous surface treatment work in Philadelphia. In the last column, headed "average total cost, first and second treatments, 1913 and 1914," is shown a saving in the different treatment of 1 ct. to 1.5 cts. per sq. yd. in 1914 over 1913. This is a result of the men becoming more familiar with the work and the better organization of the forces. This work was entirely new, both to the laborers and the supervising force in 1913. The labor cost for this work was as follows:

Laborers	$2.00 per 8 hour day
Foremen	4.00 per 8 hour day
Teams	5.00 per 8 hour day

This about covers, in a very general way, the more or less standard dust layers and bituminous surface treatments. The street cleaning work is in a cruder state than any other branch of highway work. It is work that should rightfully come under an association of this kind, because in all the towns and counties on the main thoroughfares it is becoming more and more necessary every day to do some sort of street cleaning work. It is a greater problem, of course, in the cities. There has been considerable discussion as to the proper kind of cleaning, and I am going to outline briefly the methods used in Philadelphia and Washington. The work is done under a schedule, each street is cleaned as often as it requires cleaning, or as, in the judgment of the officials, it requires cleaning and the finances will permit. In this connection I would also say that it is very easy to go too far with the cleaning of city streets. It is not necessary and the cities cannot afford to have the streets as clean as a dining room table. One of the great problems is to clean the streets sufficiently to keep the dust down, and to help eliminate the spread of disease from this cause. If you do enough cleaning to accomplish these two purposes, I believe you are doing as much as any city should do; you should not spend all your money on cleaning or on any one function of public works.

In Philadelphia each street is cleaned every day, every other day, every third day, or once a week. This is the method of cleaning for city pavements, including asphalt, granite block and wood block, etc. The macadam roads are cleaned once a week, once every two weeks, and some of them in the country districts only once a month. The cleaning of the macadam roads consists wholly of brushing into the gutters the material that has accumulated on the road, shaping up the shoulders, cleaning the gutters and carting away the dirt. Such a schedule of cleaning will keep the macadam roads in pretty good shape.

In the cleaning of city pavements three types of machines are used, machine brooms, squeegees and flushers. The machine broom cleaning is, or should be, used largely on pavements that are not sufficiently smooth to clean with the squeegee; this would include certain classes of the granite block and asphalt pavements that are more or less wavy, the brick pavements not in good condition, and all classes of pavements that are not smooth enough to scrub with the squeegee.

The flusher cleaning is intended more for granite block streets than for any other type. The water is applied at the rate of about 35 to 40 lbs. pressure, in such a way that it forces the dirt out of the joints in the pavement, and drives it over toward the curb where it is gathered up and hauled away.

The squeegees are used on smooth pavements. In all these methods of cleaning, a gang follows the machine with hand brooms and wagons and picks up the dirt that is pushed to the gutter.

All three of these types of cleaning have to be supplemented by pick-up cleaning, which is done by blockmen who are assigned to specific areas. The size of these areas depends on the amount of cleaning necessary, varying from as low as 2,000 or 3,000 yards in the center of the business section, to as high as 25,000 yards in the outlying districts. The work of the blockmen consists of taking up any dirt accumulating on the street during the time intervening between the regular schedule for machine cleaning. In some cities, the cleaning is done by gangs, who form in lines across the street and with their hand brooms push the material from the center to the side, one pushing it over to another, until it is brushed to the curb.

There was some discussion at a recent engineering meeting—the meeting of the American Society of Municipal Improvements—with reference to using water in street

cleaning, and to illustrate this point I just ran across a paper read before the American Society of Municipal Improvements by Mr. Slater of Providence, stating that it was unnecessary to use any water on their asphalt and bituminous pavements. The discussion was by Mr. Warren, and a statement was made that in Washington, for example, and New York, they do not use water. This is very misleading, because it is incorrect. They believe very much in the use of water in Washington and in New York, and also in Philadelphia. We do not believe, though, in leaving water on the street long enough to damage the pavement, and that is the main point. Squeegee cleaning consists of a sprinkler preceding the squeegees; the idea is to sprinkle sufficiently in advance of the squeegees, which also have a sprinkler attachment in front of their rubber brooms. The first sprinkling is to moisten the dirt on the pavement sufficiently in advance to loosen it up, and the second sprinkling puts enough water there for the rubber squeegee to scrub the pavement. It is very evident when this method is used, and when these rubber squeegees thoroughly scrub the pavement, that all the dust is removed, and it doesn't leave sufficient water on the pavement to do any damage.

The ideal method would be vacuum cleaning on all classes of pavements, but we haven't today any method of vacuum cleaning that has been considered sufficiently satisfactory, in a general way, to be adopted by the different cities. They are all trying to improve on the machinery with a view to getting some vacuum cleaner that will do away with some of the types of machines and methods of cleaning we are now using. I think that the question of using water on pavements should be emphasized, because it is very clear that if the water is simply put on the pavement, and the pavement scrubbed, the water will not remain long enough to do any damage.

The question of cleaning is very closely related to all of our highway work and before very long it is going to be considered an important element in connection with our maintenance costs. Up to today we have never considered in the cost of maintenance of any of our pavements, roads, types of road surfaces, or any kind of pavement of any description, the cost of cleaning; and it is a most important factor. Some types of pavement which are less durable under certain traffic conditions cost so much less to clean that it is a question whether in the long run they would not be the most economical on certain streets. In this con-

	Average per sq. yd.		Average labor cost per sq. yd.					Average mat. cost per sq. yd.			Av. total cost per sq. yd.	Average total cost per sq. yard. 1st & 2nd treat.	
	Gal. bit. mat.	Lb. cov'g mat.	Sweeping Hand	Sweeping Mach.	Chips.	Clean up	Total labor	Bit. mat.	Cov'g mat.	Total mat		1914.	1915.
REFINED COAL TAR-HEAVY-(Tarvia A) 1st Treatment	.464	16.2	.0061	.0017	.0046	.0026	.0140	.0373	.0178	.0548	.0688	.0641	.0824
REFINED COAL TAR-HEAVY-(Tarvia A) Retreatment	.261	15.6	.0038	.0008	.0112	.0024	.0182	.0244	.0167	.0411	.0593		
REFINED COAL TAR-LIGHT-(Tarvia B) 1st Treatment	.389	15.7	.0069	.0024	.0067	.0047	.0207	.0258	.0168	.0426	.0633	.0566	.0658
REFINED COAL TAR-LIGHT-(Tarvia B) Retreatment	.314	14.6	.0044	.0011	.0055	.0034	.0144	.0200	.0155	.0355	.0499		
REFINED WATER GAS TAR-LIGHT-(Ugite) 1st Treatment	.289	16.3	.0030	.0004	.0039	.0026	.0099	.0248	.0171	.0419	.0518	.0509	.0696
REFINED WATER GAS TAR-LIGHT-(Ugite) Retreatment	.301	13.4	.0034	.0006	.0067	.0003	.0110	.0238	.0148	.0386	.0500		
ASPHALT CUTBACK 1st Treatment	.346	17.5	.0057	.0021	.0061	.0042	.0181	.0420	.0198	.0618	.0799	.0758	.0868
ASPHALT CUTBACK Retreatment	.287	18.5	.0026	.0014	.0057	.0039	.0136	.0309	.0223	.0532	.0677		

Gravel —— Cost per 2000# delivered on road —— 2.14

Trap Rock Chips — " " " " " -1.749, 2.30, & 2.35 — Average 2.30

Tarvia A per gallon applied — .08½ Ugite Cold per gallon applied — .08

" B " " " — .07 " Hot " " " — .08

Asphalt Cut Back per gallon applied — .11⅔

ALL CLASSES BITUMINOUS MATERIAL —
- TOTAL SQUARE YARDS TREATED 1,034,470
- TOTAL GALLONS APPLIED 334,377
- TOTAL POUNDS COVERING MATERIAL 14,435,347
- TOTAL COST $60,407.23

TABLE SHOWING DETAILS AND COSTS OF BITUMINOUS SURFACE TREATMENT. WORK BY THE PHILADELPHIA BUREAU OF HIGHWAYS AND STREET CLEANING DURING THE SEASON OF 1914.

nection I might say that asphalt is the easiest pavement to clean. It, however, is not considered as good a pavement as granite block for heavy traffic streets, but I am not altogether sure when the cost of cleaning is added to the cost of maintenance of granite block pavements, particularly the old style of granite block which are gradually being eliminated, that the asphalt pavement would not be the cheapest in the long run.

An asphalt pavement will be less dusty with the same amount of cleaning than a wood block pavement. The dust will incorporate to a certain extent in an asphalt pavement, particularly in the warm weather, but it will not with a wood block pavement, after the bleeding is over, and this is usually the case after the second season. Most of our accidents from skidding result from improper cleaning of asphalt and wood block pavements. If these pavements are thoroughly cleaned with squeegees, there will be no scum on the pavement to cause machines to skid, and in this connection I am going to call your attention to a little detail that is one of the most important questions in street cleaning work. A number of men will state that machine broom cleaning is a thorough method for cleaning asphalt and wood block pavements. You cannot thoroughly clean a pavement with a machine broom. After cleaning you can go over the pavement and by observing very closely, you will see that where the broom has passed it has left little streaks of dust here and there, and if an automobile passes right over the road, you will find dust rising from it. When it rains on that dust a little scum forms that results in causing machines to skid.

If you thoroughly scrub an asphalt, wood block or bituminous pavement, or any smooth pavement with a squeegee, and you observe the pavement very closely after the scrubbing, you will find no dust, simply because the rubber squeegee actually scrubs the whole pavement. And when the pavement is dry, within a very short time after it has been scrubbed, if a machine passes over it, you will not find any dust arising, nor a scum in wet weather from this little film of dust, which is always left on the pavement after machine broom cleaning.

The average cost of machine broom cleaning on heavy, medium and light traffic streets for the City of Philadelphia for 1914 was $0.269 per 1,000 sq. yds.

The average cost of squeegee cleaning on heavy, medium and light traffic streets for the City of Philadelphia for 1914 was $0.151 per 1,000 sq. yds.

These prices include the cost of the removal of the street dirt and the cost of operating and the direct supervision only, and are based on the following:

Foremen	$2.50	per 10 hour day
Gangmen	1.75	per 10 hour day
Machine broom	5.50	per 10 hour day
Dirt wagon	5.00	per 10 hour day
Two-horse sprinkler	5.00	per 10 hour day
Dirt cart	3.50	per 10 hour day
Squeeges	6.00	per 10 hour day

MR. STOLTZFUS: Mr. Chairman, may I ask a question?

CHAIRMAN CROSBY: Yes, sir.

MR. STOLTZFUS: I would like to know if anybody here has any experience with what I think is called lignin liquor. If I understand the thing it is something similar to water, yet it has a binding effect something like cement.

CHAIRMAN CROSBY: Can any gentleman answer Mr. Stoltzfus' as regards the liquor?

MR. MEEKER: I have had some experience, Mr. Chairman, with this liquor, which is a by-product from the manufacture of wood pulp, and have used it on gravel roads in the southern portion of our state. Where there is quite a percentage of clay in the gravel this liquid has proven very satisfactory. The trouble with clay gravel as a road material is that it makes a very good road for from eight to nine months in the year, while during the other three or four months the surface ruts very badly. After putting on this lignin liquor the road thus treated went through last winter and the winter before without any ruts at all. Quoting the remarks of the director of one of our boards of freeholders as follows: "This lignin liquor was applied to about three miles of road and I spent about $645 in applying it. As a result the road is good to-day, while another section of road of about equal length, which did not have any lignin binder upon it, rutted and cut up so badly that it had to be reshaped and re-graveled at an expense of over $1,100, while the people lost the use of the road as a first-class highway for nearly three months."

The lignin liquor also works very well upon our red shale roads. These are of a heavy clayey nature and while very good in dry weather are almost bottomless in the spring. The results obtained from the application of the lignin liquor to this shale have been very satisfactory.

On macadam roads it does not work as well, owing to the fact that the trap rock, which we use in most of our macadam work, contains very little clay. It seems to be a prerequisite to obtain the best results that there should

be a certain percentage of clay in the road metal. In order to obtain the best results with lignin liquor the material should be properly applied, properly diluted and not applied in too large a quantity at one time. Our experience has been that about three-quarters of a gallon to the yard yields the best results if it is applied at three different times, the first treatment being about one-third of a gallon and letting that soak in before the road is thoroughly dry, and giving another application of about one-third, then a week or two afterwards giving a third light application. In that way it penetrates the road and makes a kind of cement, but if you apply it in too large quantity at first it forms a crust on top. If properly applied it gives very good results.

MR. STOLTZFUS: It has the quality of laying the dust, too, has it?

MR. MEEKER: To a certain extent. It is not a dust layer altogether. It is rather a road preservative.

C. B. ANDERSON (Joplin, Mo.): I would like to ask Mr. Connell if he uses the asphalt cut-back on gravel roads, and what results he has secured.

MR. CONNELL: I haven't used the asphalt cut-back on the gravel road, but I have no reason to believe that if you had a good clean gravel and a good smooth hard surfaced road with considerable sand in the gravel, it wouldn't work probably just as well as it would with the stone road. I know that there are cases where the other materials somewhat similar to that do give very good results. If you have any cement or clay in there, I don't believe it would give you good results.

V. NICHOLSON (Engineering Chemist, Chicago, Ill.): I would like to ask Mr. Connell, as a point of information, if there is not considerable danger in the use of cut-back asphalt, especially in tanks, from explosion if you have careless workmen.

MR. CONNELL: Well, there is a certain element of danger. I don't think there is any great danger. I have seen a good deal of it used, and know of a good deal of it being used in other localities, and I haven't heard of any accidents. The only case that I know of which might have resulted in an accident was in one case where somebody threw a match on the road, and it burned up for a time; that doesn't amount to anything. That fire didn't spread at all. As a matter of fact, one of the methods of using it is to put it on and then burn it right away, burn off all the light oils. We do some of that, too.

CHAIRMAN CROSBY: Perhaps the Chair should say that in introducing Mr. Connell, no disrespect was intended to the City of Chicago, nor Philadelphia, by referring to the latter as the second city. As a matter of fact, the Chair had in mind that Chicago was the first city and that New York wasn't a city, but an imperial municipality. (Laughter.) The other object in introducing Mr. Connell in that way was to encourage him. Perhaps that was also unnecessary. (Laughter.)

The next speaker on the program is Mr. Leininger, Superintendent of Streets of Chicago. Is Mr. Leininger present? He is not.

ARTHUR H. BLANCHARD* (Professor in Charge, Graduate Course in Highway Engineering, Columbia University, New York, N. Y.): The writer agrees with the fundamental principles of dust prevention and street cleaning as presented in the admirable discussion by Mr. Connell. Special attention should be directed to the conclusions that dust prevention and street cleaning problems are intimately associated; that street cleaning costs should be charged to the upkeep of pavements; and that street cleaning is a branch of highway engineering which requires supervision by trained and experienced highway engineers.

The formation of a large part of dust is due to the deposition of dirt adhering to the wheels of vehicles coming from adjacent earth, gravel, or broken stone roadways, the leakage of the contents of loaded vehicles both in transit and while loading and unloading, the excrements of animals, and the abrasive action of traffic. Other sources of street dust are mineral matter applied to the surface of pavements, the decay of leaves, bark, twigs, and other vegetable matter, dust from manufacturing concerns, and soot and ashes from chimneys. It is apparent that in order to have clean and dustless roadways two classes of material must be removed, fine dirt or dust and coarse dirt, such as horse droppings, leaves, paper and other forms of rubbish.

Dust and coarse dirt on earth, gravel and broken stone roads are taken care of by a combination of dust laying and street cleaning methods if the above types of construction are used in urban districts, while on roadways of the above materials on highways outside of urban districts usually only dust laying methods are employed. Dust and coarse dirt on bituminous surfaces and on bituminous, brick, block and

*Written discussion submitted but not read at the convention.

cement concrete pavements should be removed by street cleaning methods when located in urban districts and in many cases the same methods should be employed on highways outside of urban districts. Periodical watering of pavements, or the use of other palliatives, to lay the dust during the day is fundamentally wrong, as the fine dust which necessitates the use of palliatives should have been removed.

Local conditions, together with the grade and character and amount of traffic, influence to a considerable extent the method selected to keep the street as dustless and clean as possible. For instance, when the travel is largely automobile traffic, some asphaltic surfaces will absorb the dust to a large extent; on narrow, well-built-up streets under heavy horse-drawn traffic, sweeping and water flushing are usually necessary; while on open highways the removal of the dung of animals and other coarse litter may be sufficient.

Mr. Connell has very fully treated methods of dust prevention on earth, gravel and broken stone roads and exhaustively presented methods of street cleaning for the several types of pavements which are identical with the writer's practice.

The writer has found that one conclusion reached by Mr. Connell is not generally accepted by those in charge of street cleaning, namely, that the surfaces of pavements cannot be thoroughly cleaned with machine brooms. As the result of many investigations on all types of pavements, the writer heartily subscribes to Mr. Connell's conclusion and believes that material increase in the efficiency of street cleaning methods would result by a general recognition of the fact that the use of water following the machine broom is a prerequisite to insure dustless pavements.

CHAIRMAN CROSBY: The formal program is concluded, and the business meeting of the Association is scheduled to follow. It will be called immediately by the President, but before you adjourn, one or two brief announcements should be made. One is that a road convention and exhibition will be held in Toronto under the auspices of the Dominion Highway Association and the Ontario Good Roads Association, in March. A cordial invitation is extended to all present, and their friends, to attend. An invitation has been received from the Mayor of Buffalo and the Buffalo Chamber of Commerce to hold the next convention of this Association in that city. We received this morning, a letter from the Secretary of the British Road Board. It reads:

CONVENTION PROCEEDINGS

PERMANENT INTERNATIONAL ASSOCIATION OF ROAD CONGRESSES.

Local Organizing Committee, London Congress, 1913.
December 2d, 1914.

Dear President McLean:

I should be very glad when opportunity offers if you would convey the good wishes of the road builders of England for a very successful convention at Chicago.

We watch with the greatest sympathy and interest the efforts of the road builders of North America to solve the huge problem of providing your country with an adequate network of well constructed and efficiently maintained trunk roads.

I often wish that I could take a little more active part in your work, and live in hope that I shall be able to visit you again shortly, if only to travel over the great road which I believe you are trying to construct to connect the Atlantic with the Pacific Ocean.

With every good wish, believe me,

Yours sincerely

(Signed) W. REES JEFFREYS.

President W. A. McLean, American Road Builders' Association, Hotel La Salle, Chicago.

I am sure the sympathy and good wishes of the British association are appreciated by this Convention. If there is no further business before the Convention, the Chair will declare the meeting adjourned. We will now proceed to the business meeting of the Association, if you please.

Business Session

PRESIDENT McLEAN: The first matter, I believe, is to receive the report of the Committee on Credentials, Mr. A. M. Jackson, Chairman.

ALAN MAIR JACKSON: Mr. Chairman, and Gentlemen: I beg leave to submit the report of the Committee on Credentials.

Report of the Committee on Credentials.

The Committee on Credentials has been unable to hold a meeting, so as Chairman I have taken the responsibility of going through the very excellent system of registration adopted by our most painstaking and competent Secretary, Mr. Powers. As a result of this investigation of the registrations, I am proud to report that almost four thousand registrations have been made, making a very gratifying record. Of course, you will understand an absolute count of the registrations cannot be made at this stage, as people are still registering. I may say that forty-seven states of the Union are represented together with nearly 100 representatives from Canada, from eight provinces. Six foreign countries have been represented: namely, Scotland, Cape Colony, South Africa, Hawaii, the Philippines, Hungary, and Buenos Ayres, South America.

I think, gentlemen, the representation from the United States and Canada, showing as it does delegates from 55 out of a total of 59 states and provinces, is a record of which the Association and its President may very justly be proud. Moreover, this almost complete representation of the North American continent is supplemented, as I have said, by representatives from, I was going to say, the four corners of the earth, only in this case, from six corners of the earth, and those all very distant ones.

I feel sure the Association will feel proud with Mr. McLean, your President, of the representation from Canada, a great many of whose delegates have traversed considerable distances to be present.

I have the honor to be, sir, your obedient servant.

ALAN MAIR JACKSON, Chairman.

[The members of the Committee on Credentials were Alan Mair Jackson, Brantford, Ont., Chairman; J. M. McCarthy, Secretary, Massachusetts State Highway Commission; P. C. McArdle, Acting Chief State Highway Engineer of Illinois; R. Keith Compton, Chairman of the Paving Commission, Baltimore, Md.; F. F. Rogers, State Highway Commissioner of Michigan; H. W. Durham, Chief Engineer of Highways, Borough of Manhattan, New York, N. Y., and E. Brian, City Engineer of Windsor, Ont.]

MAJ. CROSBY: Mr. President, I move the acceptance of the report of the Credentials Committee, and that the thanks of the meeting be extended to Chairman Jackson for the very excellent and comprehensive report which he has read.

MR. MEEKER: I second the motion.

PRESIDENT McLEAN: Is there any discussion, gentlemen? You have heard the motion; those in favor, please say aye; opposed, no. The motion is carried.

The next item of business is the recommendation to the Association of the Board of Directors, adopted in accordance with the constitution, proposing an amendment to the by-laws.

SECRETARY POWERS: This resolution was passed by the Board of Directors at a meeting held February 27, 1914. The secretary's records are as follows:

"Moved by W. W. Crosby, seconded and carried, that the dues of the Association be raised to four dollars, beginning with the year 1915, and that each member should be supplied at the expense of the Association with a subscription to 'Good Roads.' It was also moved by Mr. Crosby, seconded and carried that the Executive Committee be instructed to take up with the publishers the matter of supplying 'Good Roads' to members of the Association, and report at the next meeting."

[After a brief discussion participated in by Major Crosby, Treasurer of the Association; President McLean, Secretary Powers and others, the amendment was adopted.]

PRESIDENT McLEAN: In connection with the letter from Mr. Jeffreys, Secretary of the British Road Board, would it not be well if the President or Secretary were authorized to reply on behalf of the Association?

MAJ. CROSBY: I make that motion, Mr. President.

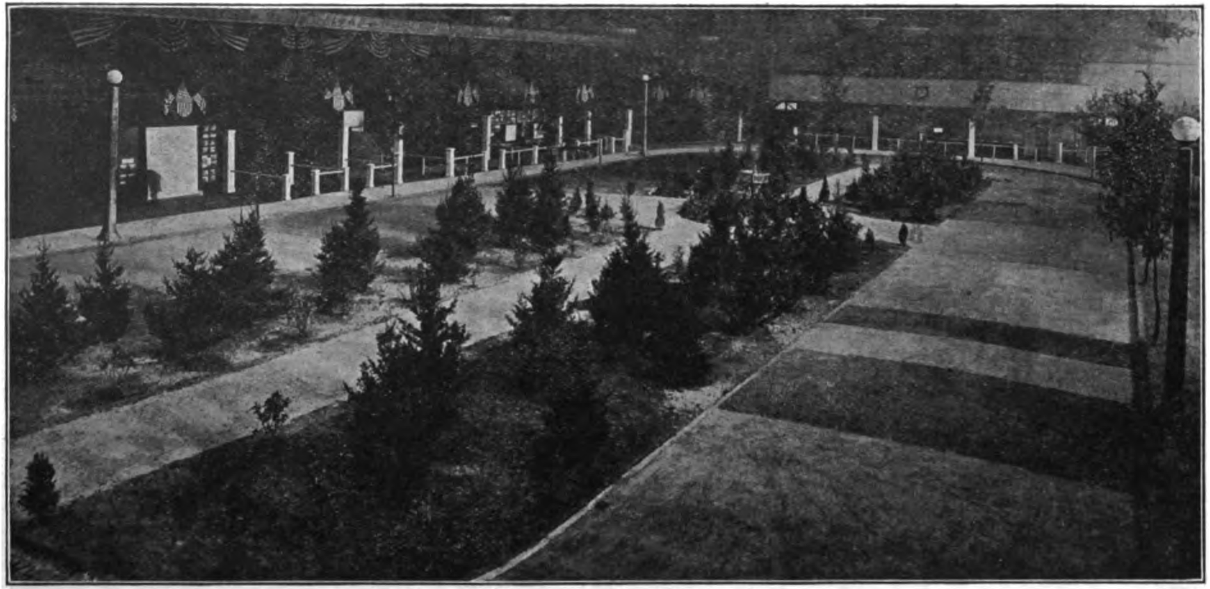
MR. MEEKER: I second that motion.

PRESIDENT McLEAN: It is moved and seconded that the Secretary be authorized to acknowledge the greetings of the Secretary of the British Road Board in a fitting manner. All in favor say aye; opposed, no. The motion is carried.

That, I think, concludes the business of the session, unless there is something else.

MAJ. CROSBY: Speaking for "the good of the order," as I remember that it has come up in the course of the meetings of the various organizations I have belonged to from time to time, I would like to suggest, if I may be permitted, that one way we can help the Association is to increase the membership. I have been trying to do something along that line myself. I know the Secretary has worked very hard in communicating with people to get them into the Association, and I merely at this time would like to ask that those present who show by their attendance here at this late hour their interest in the Association, help us if they can in getting members into the Association.

PRESIDENT McLEAN: Is there anything further? Otherwise, I will declare closed the most successful convention in the history of the American Road Builders' Association. The meeting is adjourned.



GENERAL VIEW OF THE ARENA AT THE INTERNATIONAL AMPHITHEATER DURING THE SIXTH GOOD ROADS SHOW—MODEL BOULEVARD SURROUNDING CENTRAL PARKING

List of Exhibitors

Commercial

Acme Road Machinery Co., Frankfort, N. Y.
Adams & Co., J. D., Indianapolis, Ind.
Albrecht Excavator Co., Milwaukee, Wis.
"American City, The," New York, N. Y.
American Clay Machinery Co., The, Bucyrus, Ohio.
Amies Road Co., Easton, Pa.
Arrow Motor Cartage Co., Chicago, Ill.
Association of American Portland Cement Manufacturers, Philadelphia, Pa.
Austin-Western Road Machinery Co., The, Chicago, Ill.
Ayer & Lord Tie Co., Chicago, Ill.

Baker, Jr., John, Chicago, Ill.
Baldwin Locomotive Works, The, Philadelphia, Pa.
Barber Asphalt Paving Co., The, Philadelphia, Pa.
Barber Asphalt Paving Co., The, (Iroquois Works), Buffalo, N. Y.
Barrett Mfg. Co., New York, N. Y.
Bausch & Lomb Optical Co., Chicago, Ill.
"Better Roads and Streets," Jamestown, Ohio.
Bituminized Road Co., Kansas City, Mo.
Blackmer Rotary Power Pump & Mfg. Co., Petoskey, Mich.
Bonney Supply Co., Inc., The, Rochester, N. Y.
Bucyrus Company, South Milwaukee, Wis.
Buffalo Steam Roller Co., Buffalo, N. Y.
Buff & Buff Mfg. Co., Chicago, Ill.
Burdick Enamel Sign Co., The, Chicago, Ill.

Carey Company, The Philip, Cincinnati, Ohio.
Case Threshing Machine Co., J. I., Racine, Wis.
"Cement Era, The," Chicago, Ill.
Chain Belt Co., Milwaukee, Wis.
Chicago Builders' Specialties Co., Chicago, Ill.
Chicago Creosote Co., Chicago, Ill.

Chicago Portland Cement Co., The, Chicago, Ill.
"Contractor, The," Chicago, Ill.
Cummer & Son Co., The F. D., Cleveland, Ohio.

Dietzgen Co., Eugene, Chicago, Ill.
Domestic Engine & Pump Co., Shippensburg, Pa.
Dunn Wire-Cut-Lug Brick Co., The, Conneaut, Ohio.

"Engineering News," New York, N. Y.
"Engineering Record," New York, N. Y.
"Engineering and Contracting," New York, N. Y.
Eagle Wagon Works, The, Auburn, N. Y.
Erie Machine Shops, The, Erie, Pa.

Farquhar Co., Ltd., The A. B., York, Pa.
Frohman Chemical Co., Sandusky, Ohio.

Galion Iron Works & Mfg. Co., The, Galion, Ohio.
"Good Roads," New York, N. Y.

Headley Good Roads Co., Philadelphia, Pa.
"Highway Contractor, The," Albany, N. Y.
Huasteca Petroleum Co., New Orleans, La.
Hunt & Co., Robert W., Chicago, Ill.
Hvass & Co., Inc., Chas., New York, N. Y.

Ideal Concrete Machinery Co., Cincinnati, Ohio.
Illinois Stone Club, Chicago, Ill.
Ingersoll-Rand Co., The, New York, N. Y.
International Motor Co., Chicago, Ill.

Jaeger Machine Co., The, Columbus, Ohio.
Jeffery Co., The Thomas B., Kenosha, Wis.
Jennison-Wright Co., The, Toledo, Ohio.

Kelly-Springfield Motor Truck Co., The, Springfield, Ohio.
Kettle River Co., The, Minneapolis, Minn.
Keuffel & Esser Co., Hoboken, N. J.
Kinney Mfg. Co., The, Boston, Mass.

Knox Motors Co., Chicago, Ill.
Koehring Machine Co., Milwaukee, Wis.

Lewis Mfg. Co., F. J., Chicago, Ill.

Marion Steam Shovel Co., The, Marion, Ohio.
Marquette Cement Manufacturing Co., The, Chicago, Ill.
Marsh-Capron Mfg. Co., Chicago, Ill.
Martin International Trap Rock Co., The, Bruce Mines, Ont., Canada.
Mechling Bros. Mfg. Co., Camden, N. J.
Monroe & Sons, N. S., Arthur, Ill.
Municipal Engineering & Contracting Co., Chicago, Ill.
"Municipal Journal," New York, N. Y.

National Paving Brick Manufacturers' Association, Cleveland, Ohio.
Novo Engine Co., Lansing, Mich.

Orenstein-Arthur Koppel Co., Chicago, Ill.
Orr & Sembower, Inc., Reading, Pa.

Philadelphia Quartz Co., Philadelphia, Pa.
Power & Mining Machinery Co., Cudahy, Wis.

Rapid Mixer Co., Grand Rapids, Mich.
"Road Maker, The," Des Moines, Ia.
Robeson Process Co., New York, N. Y.
Roche, Thos. M., Chicago, Ill.
Rocmac Road Corporation of America, Ltd., Philadelphia, Pa.
Russell Grader Mfg. Co., The, Minneapolis, Minn.

Semet-Solvay Co., Syracuse, N. Y.
Smith & Co., C. B., Cleveland, Ohio.
Smith Co., The T. L., Chicago, Ill.
Standard Asphalt & Rubber Co., Chicago, Ill.
Standard Oil Co. (an Indiana corporation), Chicago, Ill.
Standard Scale & Supply Co., The, Chicago, Ill.
Steel Protected Concrete Co., Philadelphia, Pa.

Streich & Bro. Co., A., Oshkosh, Wis.
Tarrant Mfg. Co., Saratoga Springs, N. Y.
Thew Automatic Shovel Co., Lorain, Ohio.
Troy Wagon Works Co., The, Troy, Ohio.
Trussed Concrete Steel Co., Youngstown, Ohio.
Turbine Sewer Machine Renovating Co., The, Milwaukee, Wis.

United States Asphalt Refining Co., The, New York, N. Y.
United States Wood Preserving Co., New York, N. Y.
Universal Portland Cement Co., Chicago, Ill.
Utility Road & Farm Machinery Co., Chicago, Ill.

Warner-Quinlan Asphalt Co., New York, N. Y.
Warren Brothers Co., Boston, Mass.
Watson Wagon Co., Canastota, N. Y.
Wheeling Corrugating Co., Chicago, Ill.
Wiard Plow Co., Batavia, N. Y.
Wisconsin Granite Co., Chicago, Ill.

Zindorf, M. P., Seattle, Wash.

National, State and Municipal

Office of Public Roads, U. S. Department of Agriculture.
State of Arizona.
State of Illinois.
State of Massachusetts.
State of Michigan.
State of New York.
State of Wisconsin.
Province of Ontario, Canada.
City of Chicago.
City of New York.
City of Philadelphia.

ANNUAL ASSOCIATION MEETING

The annual meeting of the Association, as provided for in Chapter 1, Section 1, of the By-Laws, was held at the Hotel Astor, New York, N. Y., February 5, 1915.

At this meeting reports of the Executive Committee, Secretary and Treasurer were duly read and accepted. These reports are given on this and the following pages.

Executive officers and six directors were elected. The list of officers and directors for 1915 will be found on page 368.

By vote of the members of the Association present, the resolution passed by the Board of Directors at its last meeting, providing that Chapter V, Section 1, of the By-Laws should be amended so that the annual dues for active members should be $3.00 per year, was approved.

The Committee on Standards presented a progress report. It was moved and carried that the report of the Committee be published in the annual proceedings of the Association. This report will be found on page 339.

A progress report of the Committee on Legislation was also presented. It was moved and carried that this report be printed for further discussion. This report will be found on page 359.

A dinner, which was attended by members and guests, was held at Rector's, New York City, 6.30 P. M.

Following the dinner the tellers announced the result of the ballots cast for officers and directors.

The tellers also reported that the vote on the amendment to Article VI, Section 1, of the Constitution, had been carried by a large majority. The section now reads as follows:

Annual Report of the Executive Committee of the American Road Builders' Association

New York, February 5, 1915.

To the Board of Directors, American Road Builders' Association.

Gentlemen: In accordance with the By-Laws, Section 8, Chapter III, the Executive Committee submits its annual report herewith as follows:

During the past year 233 new members have been added to the membership of the Association, and 17 members have dropped out, leaving a net total of 875.

A Membership Committee, consisting of 110 members, was appointed in accordance with the recommendation made by the Executive Committee a year ago. The work of this

committee resulted in securing a substantial increase in membership and of men in every way creditable to the Association. It is recommended by the Executive Committee, therefore, that this committee be continued or a new one named, and the work of securing new members be pushed forward as much as possible.

The reports of the Treasurer and Secretary, both of which are herewith submitted, show that on December 31, 1914, there was a balance on hand of $3,178.63, and that there were bills receivable amounting to $4,458.11, and accounts payable amounting to $2,860.47, leaving a net surplus of $4,776.27.

The Eleventh Annual Convention was held in Chicago, December 14, 15, 16, 17 and 18, 1914. The registration list showed a larger attendance than at any previous meeting of the organization. In fact, it is believed to have been the largest gathering of those interested in road-building ever held.

The show or exhibition of machinery, materials and methods occupied a greater space than anything of the kind ever held. The commercial exhibitors numbered 108. There were six State exhibits and three city exhibits. There were also exhibits from the United States Department of Agriculture and the Province of Ontario, Canada.

The total space sold for commercial exhibits amounted to $13,400.12. The total expenses, including traveling expenses of members of the Executive Committee and other officials necessary to carry on the convention, were $10,245.51.

A unique feature of the show at Chicago was the model boulevard. The work involved in carrying out the work was very considerable, but it is felt that the result achieved warranted the expenditure of the few hundred dollars involved beyond what the manufacturers who laid the pavement paid for.

At the Chicago convention a progress report of the Committee on Standards was presented by the chairman, Nelson P. Lewis. This report was received, and it was voted to present the final report at the annual meeting, February 5.

At the Chicago convention a progress report of the Committee on Legislation was presented by Chairman W. A. McLean. It was voted that this report also be taken up and final action taken on same at the annual meeting, February 5.

At the meeting of the Board of Directors, held in Chicago, December 17, a resolution was passed requesting the Secretary and Treasurer to present to the Executive Committee a complete financial statement of the affairs of the Association, with a view to a recommendation by the Executive

Committee for some plan that will enable the Secretary to carry on the duties of his office and relieve him of the necessity of devoting the amount of time that has been found necessary in the past.

The Board of Directors, at a meeting held February 27, 1914, passed a resolution providing that the dues of the Association be raised to $4 per year, and include a subscription to "Good Roads." This resolution was also taken up at the business meeting of the Association held in Chicago, December 18, 1914, and approved by vote of the members. The resolution provided that the Executive Committee make arrangements with the publishers of said magazine as to the rate that the Association should pay for the publication to be sent to all members. The committee has had conferences with the publishers, and they have agreed to send the fifty-two issues of the journal per year to each member of the Association for $1 per year, or one-half the regular subscription price.

There has developed, however, some criticism outside of the Association regarding this procedure, and the publishers of "Good Roads" have agreed that if the annual dues of the Association are fixed at $3 per member, they will furnish the magazine to all members who desire to receive it at the rate of $1, as already referred to. The Executive Committee understands, of course, that if this latter scheme is adopted it will require another amendment to the By-Laws. It is therefore submitted to the Board of Directors for consideration. Respectfully submitted,

EXECUTIVE COMMITTEE,
(Signed) Geo. W. Tillson, Chairman.
R. A. Meeker.
E. L. Powers.

Secretary's Report

December 31, 1914.

To the Board of Directors,
American Road Builders' Association.

Dear Sirs: In accordance with Section 6, Chapter III, of the By-Laws, I have the honor to present a report, showing the receipts and disbursements of the Association by the Secretary for the year from December 31, 1913, to December 31, 1914, as follows:

1914 RECEIPTS		1914 DISBURSEMENTS	
Jan. 1, Cash on hand	$2,386.22	Monies received from current sources and sent to Treasurer Crosby January 1, 1914, to December 31, 1914.	$15,493.04
Exhibition Space..	10,757.97		
Notes receivable accepted in settlement of unpaid accounts...	$66.00		

Membership dues.	996.00	Notes receivable sent to Treasurer Crosby January 1, 1914, to December 31, 1914	366.00
Sundries	1,704.11	Dec. 31, Cash on hand	351.26
	$16,210.30		$16,210.30

I also present herewith a general balance sheet, showing assets and liabilities of the Association:

GENERAL BALANCE SHEET

1914 ASSETS		1914 LIABILITIES	
Dec. 31, Cash on hand, Treasurer	$2,827.37	Dec. 31, Accounts payable	$2,860.47
Cash on hand, Secretary	351.26		
Due from exhibitors	3,354.15		
Due for electric service	25.21		
Due for model boulevard	751.11		
Due for sundries..	14.14		
Membership dues for 1913 and 1914 unpaid	313.50	Surplus	4,776.27
	$7,636.74		$7,636.74

(Signed) E. L. POWERS,
Secretary.

Treasurer's Report

December 31, 1914.

To the Board of Directors, American Road Builders' Association.

Gentlemen: As required by Section 6, Chapter III of the By-Laws, I herewith submit my report as Treasurer for the year:

Balance on hand January 1st, 1914,		
In Corn Exchange Bank, New York....	$ 155.65	
In Essex National Bank, Montclair, N. J..	1,409.74	
In hands of Treasurer..................	1.38	
		$1,566.77
Received from the Secretary January 1st, 1914 to December 31st, 1914..........	$15,858.03	
Received from the Essex National Bank interest on account for year ending December 31st, 1914	12.39	
		15,870.42
Total		$17,437.19
Paid Audited Vouchers for current business, January 1st to December 31st, 1914		$14,609.82
		$2,827.37
In Corn Exchange Bank, New York......	$157.93	
In Essex National Bank, Montclair, N. J....	1,282.94	
In hands of Treasurer...................	1,386.50	
		$2,827.37

Respectfully submitted,

(Signed) W. W. CROSBY,
Treasurer A. R. B. A.

Report of the Committee on Standards of the American Road Builders' Association

To the American Road Builders' Association:

At the Chicago Convention held in December last your Committee on Standards presented a progress report briefly outlining the work which it had undertaken and recommending that the committee be authorized to submit a fuller report at the annual meeting of the Association, in order that such report, if so ordered at the said meeting, might be printed in the proceedings for the past year, making it available for examination and discussion by the members with a view to definite action on the subject matter at the next annual convention.

At a meeting of the committee held in Chicago a subcommittee was appointed to prepare a draft of the report for submission at this meeting.

This committee has undertaken the work assigned to it in the belief that the members of the Association did not desire to have presented for its consideration highly technical specifications for the different classes of highway work. The preparation and the standardization of such specifications have been undertaken by various technical societies, such as the American Society of Civil Engineers, the American Society for Testing Materials, and the American Society of Municipal Improvements; and your committee did not think it wise to attempt to duplicate the work which is thus being done, but that it should confine itself to the presentation of certain rules and the enunciation of certain standards for highway work which could be understood and complied with by foremen, inspectors, and the great number of men without special technical training who are engaged in the work of highway construction and maintenance in the various parts of the United States. Your committee has divided its work into seven different subjects, each of which was assigned to a separate subcommittee. Some of these subcommittees have prepared quite exhaustive reports, while others have presented very little, other than a few general observations. Our report will deal with the several subjects, but without attempting a separate presentation of each, outlining first a few general principles which should govern all of those responsible for highway construction and maintenance from the head of the highway department to the humblest workman.

General Rules

A brief code of rules and instructions should be placed in the hands of every man engaged in road work. These

rules should be simple, clearly expressed, and not include too much detail; they should be followed faithfully and violation of them should be considered sufficient ground for dismissal.

Individual responsibility of every man for the particular work under his charge should be rigidly insisted upon.

Every foreman or superintendent should personally see that the portion of work for which he is responsible is carried out in accordance with these rules and the specifications where work is done by contract.

Engineers, superintendents, inspectors and foremen should know the road laws of their state and see that they are enforced, and should also be familiar with employer's liability and labor laws.

Road repairs and reconstruction are inevitably attended by inconvenience, but they should not be attended by danger, every precaution being taken to warn those using the road where special caution is necessary.

Road machinery should be kept in thorough repair, especially that which during operation is exposed to dust. Use plenty of oil; paint frequently; keep extra parts on hand; see that every machine and tool is in working order; and keep all under cover when not in use.

Grass and weeds should not be allowed to grow on the shoulders of the road or in the gutters.

Grass, weeds and mud from the gutters do not furnish a good road surface. They should be removed and not placed upon the traveled road.

New material should never be placed on the road without first preparing the surface to receive it and when placed it should not be left for the traffic to consolidate.

The road roller, the scarifier and the sprinkling wagon are as essential as the small tools and they should be constantly used during the working season.

A road cannot be properly repaired in dry weather without a liberal use of water.

Culverts, drain pipes and their outlets should always be kept free.

Surface water should be carried off the road and away from it as soon as possible; it should never be allowed to get under the road.

Excessive crowns force travel to confine itself to the center of the road and thereby shorten its life.

There is almost always good local material available for construction and repair. This should not be overlooked.

The amount of material required for repairing or resurfac-

ing the road should be determined by careful measurement, not by guess.

If no criticism of the road is heard, it does not follow that it does not deserve criticism, and improvements should not be deferred until their need is shown by such criticism.

Field Tests of Materials Used in Road Making

The following tests will prove of value in the field, but it must be understood that they are indicative only. Further and more complete tests should be made in the event of these field tests indicating unsatisfactory qualities in the material.

MATERIAL	QUALITIES REQUIRED	FIELD TESTS
Gravel (a) For Gravel road construction	Hardness and toughness of pebbles.	Breaking with hammer, rubbing and striking together.
	Grading and proportions of different sizes of pebbles, all sizes to be present.	Observation and use of screens if available. 1½-in. pebbles largest allowable.
	Shape of pebbles.	Observation — a large number of flat pebbles objectionable.
	Presence of binding material in proper proportions.	Use of screens—should not contain less than 20% or over 30% sand or clay.
	No excess of earthy material or quicksand.	Use of screens—not over 5% should pass No. 50 screen.
	Cementing Qualities.	Observation in pit. A vertical face and presence of lumps of cemented gravel indicate good cementing value.
	Mineral composition.	Observation under hand glass.
Gravel (b) for concrete roads.	Cleanliness.	Washing in jar of water and noting scum which gathers on top. Close examination of small pebbles for coating of clay.
	Grading of sizes, all sizes to be present.	Use of screens. Not more than 6% should pass 100 mesh and not more than 15% 50 mesh.
	Hardness and toughness of pebbles.	See above.
	Shape of pebbles.	See above.
	Mineral composition.	Observation under hand glass.
(c) for concrete bases.	Same as above.	Same as above except maximum size of pebbles may be increased to 2½ ins. or 3 ins.
Sand	Hardness or sharpness.	Rubbing with fingers or between palms of hands.
	Size and proportion of pebbles.	Use of screens—all to pass ¼-in. mesh; not over 10% to pass 50 screen; not over 3% to pass 100 screen; silt and clay not to exceed 3%.

	Cleanliness.	Shaking with water and allowing to settle. Depth of scum on top will indicate percentage of earthy matter. When rubbed between palms, an excess of clay is indicated by a decided discoloration of the hands.
	Mineral composition.	Examination under hand glass.
Stone For concrete or macadam road construction.	Size.	Observation and use of screens if available. Should adhere closely to specified sizes, but a small percentage of smaller sizes is not objectionable.
	Cubical fracture.	Observation—objectionable if broken in flat pieces.
	Soundness.	Should not contain fragments of weathered rock, which is indicated by discoloration; porosity renders stone objectionable.
	Cleanliness.	Observation—if stone is not free from loam or clay, it is unsuitable for surface course.
	Toughness; not flinty.	Striking with hammer and noting manner of breaking.
	Hardness.	Scratching fresh surface with knife. Observation
Granite **Trap**	Small crystalline structure. Cubical fracture.	Observation and breaking with hammer.
Paving Brick	Hardness and toughness.	Striking together—a metallic sound denotes hardness. Striking edges with hammer—resistance to chipping denotes toughness. Let one brick drop, flatwise on a second brick, on edge, from a height of 4 feet. Neither brick should chip or break.
	Density.	Breaking brick and noting whether texture is uniformly fine or granular. Observation.
Clay tile and Vitrified tile.	Absence of cracks. Hardness and toughness.	Striking together or with hammer and noting metallic sound.
	Uniform texture.	Breaking with hammer and noting structure. Observation.
Cement tile	Form. Sufficient curing.	Handling and striking with hammer. As above.
	Hardness and toughness and uniform texture.	Observation.

Portland Cement	Form. Proper time of setting.	Make a small pat of neat cement with 20% of water by weight and note time taken to harden sufficiently to resist penetration by thumb nail. This should not take less than one hour nor more than ten hours.
	Soundness.	Place a pat, made as above on a piece of glass, so that it is 3 ins. in diameter and ½ in. thick. Keep under moist cloth for 24 hours and then in steam at atmospheric pressure for five hours. It should remain firm and hard and show no signs of decided distortion, checking, cracking or disintegration. Another test is to make a ball of neat cement 1 in. in diameter, allowing it to dry for two hours in air. Then place it in water for from 1 to 10 days. It should show increasing hardness and no signs of cracking or crumbling.
		Cements failing to pass the above tests should not be condemned but should be held subject to further investigation.

Earth and Gravel Roads

Although the mileage of improved roads has grown enormously, the vast majority of the road mileage of this country is and will continue to be of earth roads with such addition of gravel or other hard material as may be readily available for the improvement of their surface. Careful location and thorough drainage will go far toward making the earth road a most agreeable surface for travel during the greater part of the year. The split log drag is the cheapest and at the same time the most effective instrument for maintaining earth or gravel roads which has yet been devised. Where systematically used and where there is proper drainage, a gravel road can be kept in very fair condition throughout the entire winter, provided the traffic is not very heavy, and it may be assumed that where there is very heavy traffic more substantial roads have been or soon will be constructed.

Sand-Clay Roads

The road made of a mixture of sand and clay has lately become recognized as a distinct type of road, and in many

parts of the country is the only road improvement which is sufficiently low in cost to be practicable. This type of road has been more generally used in the Southern States than in other parts of the country, and the following notes and directions are intended to apply more particularly to that locality. Such roads have been used in New England and some other northern states where the winters are more severe, and some modifications of the methods described may be needed in such localities, while during extremely dry weather in summer it may be found necessary to use oil or other surface applications. The same care and preparation should be employed in preparing the roadbed as when the harder or more durable road materials are to be used. The portion of the road to be surfaced with sand-clay should be left nearly flat and at such a level that the shoulders will meet the pavement surface of the portion to be improved. The thickness of the surface will depend upon the character of the subsoil.

Before beginning the construction of a sand-clay road, both the sand and clay in the vicinity of the road should be examined to ascertain whether they have the right properties necessary to build a first-class road. The best sand or gravel to use is that which is sharp and not too fine. A clean, sharp grit, such as is desired in making mortar, is the quality of sand that is wanted, but the best results are obtained when the sand is coarser than that used for mortar. While any clean sand will make a sand-clay road, the sharper the grit the better the resulting road. The characteristics which are most desirable in the clay are plasticity and the ability to slake well when it first becomes wet. A clay is called plastic when it becomes sticky or dough-like when mixed with a certain amount of water, so that it can be molded or pressed into various shapes which it will retain even after it has been dried. If a lump of such clay is put in water, it will usually retain its form for a long time. There are other clays, however, which will immediately fall to pieces when placed in water as a lump of quick-lime will do under similar conditions. Such clay should be avoided. There is still another physical characteristic of clay which is to be considered from the standpoint of the road builder. Some clays shrink when dried, which is shown by the cracking and breaking up of their surfaces. Shrinkage would do no harm if the clay would stay in this condition, but it does not. When water, removed by evaporation, is restored to the sand-clay mixture, it causes the grains of sand to become separated. This property cannot be overcome, for it is in-

herent in the clay, but we can in some measure modify this fault by using less clay in the composition. This, however, will weaken the road and cause it to break up in dry weather. Avoid such clays if possible.

One good test for a clay is to wet the thumb and place it against the clay, and if it sticks to the thumb it is of the right quality for making a sand-clay road. If, on the other hand, it does not stick to the thumb, it is safe to say that this particular clay will not make a good binder. In general, select the stickiest clay and the sharpest sand available.

The proportion of sand and clay in the best sand-clay road should be such that there is just a sufficient amount of clay, and no more, to fill the voids between the grains of sand when these grains are touching each other. If too large a proportion of clay is used, the grains of sand are prevented from touching each other and are able to move about each other in the mass of clay, so that the resistance of the mass to the wearing effect of traffic is practically no more than if the road were composed simply of clay. Water is also able to act upon the mass of clay and the road becomes sticky and muddy. If there is too small a proportion of clay used, the grains of sand are not cemented tightly together and the road disintegrates very quickly under traffic and rain.

The exact proportion of sand and clay for making the best sand-clay road cannot be stated, as the proportions vary with the character of the sand, according to its sharpness, percentage of foreign material and size of grains. Approximately there is in a sand-clay road about 80% sand and 20% clay. One simple means of determining the proper amount of pure clay that should be added to any sand that is to be used in the construction of a sand-clay road is to fill a glass tumbler brimfull with the sand that is to be used and then fill a similar tumbler with water; pour the water carefully into the sand until the water comes flush with the surface, which will mean that all the voids between the grains of sand are now filled with water. The amount of water that has been poured into the tumbler containing the sand will represent the proportion by volume of clay that it is necessary to add to that particular sand to fill all the voids with clay.

A suitable clay may be found in the subsoil of the road, to which sand must be added; or the sand required may be the subsoil to which clay must be added; or it may be necessary to go elsewhere for both.

Method of Mixing Sand and Clay

Having determined the source of supply of the best materials for making a sand-clay road, the next question is the mixing of the materials, and this varies with the character of the subsoil, whether this is a sand to which clay is to be added or clay to which sand is to be added, or whether both sand and clay have to be hauled onto the road. It will be found that it is much easier to make a sand-clay road where the subsoil is a clay.

CLAY SUBSOIL.—The road should be properly located and graded and then the surface of the road shaped with slope from the shoulder to the ditches. The surface of that portion of the road that is to be sand-clayed should be about two or three inches lower than what is desired when the road is completed. When this is finished, the portion of road that is to be a sand-clay road, either nine or sixteen feet in the center, should when perfectly dry be plowed to a depth of three inches and thoroughly harrowed with a disc harrow. The sand should then be spread over the surface to a depth of four inches and thoroughly harrowed in, and then four more inches of sand spread over the surface, and again thoroughly harrowed. After this mixing of the sand and clay is completed, the road should be dragged. A slight crust will form, but with the first rain this will break through, for the mixed sand and clay underneath have not cemented but are loose particles. After the first heavy rain, the road should again be harrowed and then dragged into shape so as to give it the proper crown, and it will then become a firm, hard-surfaced road. If a roller is convenient, this may be used to advantage.

Very often this second mixing is left entirely to teams. In the end a satisfactory road is obtained, but it takes a much longer time.

If the sand-clay road is constructed as outlined above and good, clean, sharp sand is used on a plastic clay, a first-class sand-clay road will be the result.

In too many instances in constructing a sand-clay road the sand has simply been spread over the clay and it has been left for teams to mix it in with the clay. This takes a long time, and very often there is not a thorough mixing of the two materials, so that the road is not always uniform in its construction and does not give as good satisfaction as when constructed by the method described above.

If the sand is added to the clay road when it is wet, the harrowing can all be done at one time, and, when shaped

up and dried out, it becomes a hard-surfaced road. The main objections to making the sand-clay road in this way are that unless the clay road is extremely muddy and wet the harrowing of the sand into the clay causes considerable of the clay to get into round balls, which are not broken up by the harrowing; and there is not as good a mixture of the sand and the clay as when they are thoroughly mixed dry and then harrowed later when they are wet.

SAND SUBSOIL.—If in making the sand-clay road we start with a sand subsoil and have to add clay to this, the method of procedure is somewhat different. The sandy road-bed should be left flat and then a layer of clay spread over it to a thickness of 3 to 7 inches, according to the quality of the clay and the amount of sand which it contains. If it is a very pure plastic clay, it will take a much smaller amount than if it is a very lean or sandy clay. There should then be spread over the clay a layer of clean sand and the road thoroughly harrowed. After this has been accomplished, the road should be brought back into shape and then after a heavy rain again harrowed and shaped up. There is usually a tendency to get too much clay in making a sand-clay road when the sand is the subsoil. If the clay that has been used is a very plastic clay, there is a tendency for it to ball and cake so that a plow can very often be used to advantage in breaking up the lumps. If, however, the mixing is made when everything is perfectly dry, a pretty complete mixture can be obtained by harrowing, unless the clay has been dug when it was wet.

One difference in making a sand-clay road with a sand subsoil instead of a clay subsoil is that the number of loads of clay that it is necessary to haul is much less than the number of loads of sand.

The cost, however, of obtaining a thorough mixture of clay on sand is greater than with sand on clay.

As stated above, it is impossible to determine exactly the proportions of sand and clay to use either in making the sand-clay road on a clay subsoil or on a sand subsoil; and, therefore, as the road dries out and sets, it should have careful attention after it is completed to determine whether it is necessary to add any more sand or clay. If there is too much clay, there will be a tendency for the surface of the road to get sticky or muddy in wet weather and for the clay to ball and cake, and, if this is the case, a thin layer of sand should be spread over the surface. On the other hand, if the surface of the road loosens in dry weather, it is an indication that the clay that has been used is not

a good quality of clay and does not have sufficient binding power. More clay should be added and worked into the road.

Summary

CLAY BASE.—1. Have the top of the clay grade smooth and about 2 or 3 inches lower than it will be when finished.

2. Plow and harrow the top for the width the sand is is to be put on, leaving loose but smooth, with no big lumps.

3. Spread an even layer of sand about four inches deep over the top and plow and harrow.

4. Spread four more inches of sand over the top and harrow and drag thoroughly.

5. Use clean, coarse sand, even if it has to be hauled some distance.

6. When possible, harrow just after a rain.

SAND BASE.—1. Smooth the sand road, leaving it perfectly flat.

2. Spread the clay the desired width and from 3 to 4 inches thick.

3. If the sand base is clean sand, drag it up on the clay for a thickness of four inches and plow, harrow and drag thoroughly, preferably after a rain.

4. If the sand base contains loam, haul clean sand from a pit.

5. Use a natural sand-clay mixture in preference to pure clay.

Instructions for Inspectors and Foremen Engaged in Maintenance and Repair Work

Sand Roads

Roads constructed of pure sand are at their worst in dry weather. They are fairly good for light vehicles when wet but never present a hard surface except when frozen. Their cross section should be nearly level with shallow gutters. The moisture in sand roads should be conserved wherever possible. Shade trees help to do this, particularly along the south and west sides of the road. Frequent scraping with a road grader or drag is usually a waste of time. This is one type of road which is not generally improved by attempts to care for it. It had better be left alone until it can be replaced by something better.

Clay Roads

Roads which are built of clay become compact and firm in dry weather and are greatly improved by the frequent

use of the road drag and occasionally of the road grader. The necessity of complete drainage is obvious as when wet such roads soon assume very bad condition.

When and How to Use the Drag

Begin as soon as the frost has left the ground and the road begins to dry. Drag soon after every prolonged rain throughout the season, and in the fall just before the ground freezes. If the frost leaves the ground during the winter, use the drag, but do not attempt to use it on a perfectly dry road. Use the drag so as to force a little of the material toward the center of the road, Let the team straddle the wheel drag, going down one side and back on the other. Ride on the drag, unless the load is too heavy. Where this instrument is used thoroughly there should be a separate drag for every two or three miles of road. It is important that it should be used when and as often as the soil conditions are such as to produce the best results.

Gravel Roads

For maintaining the gravel road, as well as the earth road, the drag is the most effective machine which can be used. The surface of a gravel road will become soft during wet weather and should then have a thin layer of fresh material applied to it which will mix under travel, and the surface should be kept smooth by the frequent use of the drag. As in the case of the earth road, the gravel road should never be dragged when it is dry. The most effective time to do this work is in the late fall and in the spring when the frost is coming out of the ground and before the gravel is fully settled.

Water Bound Macadam

When a road of water bound macadam is worn thin and in bad surface, it needs resurfacing. First find out how much new stone is needed. This can best be determined by cutting a trench across the road and seeing how much old stone remains; and it is easy to compute the number of cubic yards or the number of tons, if purchased by weight, required for each mile of road. The surface of the old road should first be loosened by a scarifier, but in loosening the stone every precaution should be taken to prevent disturbance of the underlying earth foundation. After the road surface is thoroughly broken, the material may be reshaped to proper crown, by using forks and rakes, seeing to it that the fine material goes to the bottom of

the layer. If this cannot be done, a screen should be used to eliminate the fine stuff and the road then reshaped. When this is completed, add the new stone, preferably of the same kind as already in the road; but when new stone is applied as a separate course of uniform depth, this is not necessary or important. But it is important not to dump the stone in piles on the grade. Dump at the side, preferably on boards, and shovel onto the grade, otherwise the surface is almost certain to become wavy. On old roads which have been worn very thin, it is best to add enough stone ranging from 1¼ inches to 2½ inches to rebuild the bottom course, and after this is thoroughly rolled apply the second course as herein described.

Care should be taken in spreading the stone to a true crown, with a fall from the center line of the roadway, of from ½ to ¾ of an inch to each foot. This fall should be maintained after the work is finished.

Rolling should be done with a ten-ton roller. It should commence at one edge of the roadway and progress toward the center, first on one side, and back on the other, the roller traveling parallel with the center line of the road; after reaching the center of the road, the roller should pass over the center of the road to make it solid. This method prevents either pushing the crown out of line or the flattening of it. A power roller is much more effective than a horse roller. If, in the first passage of the roller, any low spots are detected, they should be immediately brought to the proper level by the addition of more stone of the same size and again rolled. If laid in two courses, the lower course may be filled with screenings, sand or gravel and again rolled, but no surplus fine material shall be left on the surface. This method provides a firmer foundation and is the best practice if funds will permit.

After this, a top course of No. 2 (that which will pass a 1¼-inch screen and be caught on a ¼-inch screen) should be evenly spread over the surface of the foundation with shovels or a spreading wagon. Do not permit it to be dumped on the foundation and spread either with rakes or shovels, as it is almost certain to produce a wavy surface.

Then sprinkle with water and thoroughly roll. As the rolling progresses, more screenings should be added as needed, and the sprinkling and rolling continued; when the proper amount of screenings and water have been added, a small wave of grout will be pushed along in front of the roller. The road should not be opened for traffic until dry.

Variations from the Foregoing Method

If the roadway presents an even surface, and has developed a horse track or worn traveled way for a width of, say, from 6 to 8 feet in the center, but is not much worn at the sides, a complete resurfacing is not necessary, but all holes and depressions should first be filled, tamped and rolled, after which the center or horse track may be thoroughly swept with stiff brooms and, if possible, wet or sprinkle the road surface. Then add No. 2 stone of the same kind as that used in the construction (without scarifying) to restore the crown. The application should be of sufficient depth to create a mechanical bond, and the road should be rolled after the stone is applied and brought to proper surface and grade.

Where the wear has been uniform but the surface is becoming loosened, and the edges worn thin, expense may sometimes be saved and the solidity of the road preserved by merely scarifying or picking up a narrow strip on each side of the road and thoroughly sweeping the middle surface, with stiff brooms, free of all dust and dirt, applying No. 2 stone as above directed. Sprinkle and roll to a true grade and even surface. A layer of dust will prevent the new material from bonding with the road surface, and the new layer will break up.

Sometimes, when the road is more worn, the scarifying may be reduced to shallow hand-picked grooves, about one foot apart and parallel to the center line of the road. If this plan is adopted, the road should first be patched to fill up all holes and depressions and the patches rolled. The roadway should then be thoroughly cleaned of all dust, dirt and refuse, and abundantly soaked with water, and the new stone spread to true crown and grade, and sprinkled and rolled as above described.

CAUTION.—Never put a two or three-inch blanket of screenings on the prepared foundation of your road and expect to bind or bond it by wetting and rolling. It is a waste of time and money.

It frequently happens that experience will show that the travel over a macadam road is too heavy for economical repair or maintenance. This is especially true where there is much motor traffic. This condition is made manifest by the fine binding material being pulled out of the surface, exposing the tops of the larger stone, and in many instances an examination will show that the stones are somewhat loose and not firmly bound together. In such cases

it may be better and cheaper to resort to bituminous surface treatment, hereinafter described in a general way, but, if this is to be done, it is best to do it under the direction of a skilled operator or engineer.

Bituminous Surface Treatment

Many macadam roads are now repaired by what is known as surface treatment. This is essentially a modified form of bituminous construction by the penetration method. A typical example of this process is as follows: The old road is thoroughly cleaned of all dust and refuse; bituminous material of the character and quality prescribed by the engineer is applied to the surface to the amount of ¼ gallon to the square yard, followed by a uniform coating of clean screenings. These screenings should not exceed ½ inch in greatest diameter. If ruts or holes are present, they may be brought up to a true surface with screenings. The road is now rolled; another application of ¼ gallon to the square yard is made and a second course of screenings applied. Such depressions as develop should be filled with screenings as the work proceeds and a sufficient excess of bituminous material should be given to such spots. A supply of surface screenings should be left along the road when such repair methods are used, so that they may be spread subsequently to take up any excess of bituminous material on the surface.

Maintenance

CAUSES OF WEAR.—Water, if allowed to stand on a macadam surface will soften it and cause it to wear out rapidly. When the frost is coming out of the ground in the spring, the surface of a macadam road will be soft, and should be rolled. (Be careful not to roll when too soft.) The effect of horse-drawn traffic is to cause a "horse path" to form in the center of the road; the wheels in turn always going in the same place, will form ruts, particularly when the road is soft. The grinding action of the wheels wears the stone and forms dust, which in a dry state, is swept away by the wind, leaving the top stones of the surface exposed in which condition they are easily displaced by traffic. Heavy automobile traffic will cause the macadam surface to ravel very quickly when the upper stones are so exposed.

A road which is not properly maintained, quickly becomes a bad road.

To meet the above conditions, the following general rules are given:

First see that the gutters and culverts are open and clean, and the drainage is perfect.

The road shoulders must be kept smooth and free from weeds and grass. Small holes and gulleys on the shoulders and embankment should be filled up as soon as they appear.

The surface of the road should at all times be kept smooth; any chuck holes or ruts which hold water, should be filled as soon as formed, since such depressions permit water to get to the foundation, and are enlarged very rapidly by traffic. Broken stone of the same size as is used in the upper course should be used in filling depressions and ruts, and ordinary screenings should be added after the stone is tamped in, and the patch thus made left a little higher than the surrounding surface in order to allow for compression by traffic. If this cannot be done continuously, it should be done at least before and during the heavy hauling seasons. Before the stone is put in the holes or ruts, the mud or dust on the surface should also be removed as well as all grass and weeds. Dust is not only objectionable from the standpoint of comfort for travel, but it forms mud which keeps the surface of the road moist, and more or less soft for a long time.

Don't let loose stones remain on your road, and do not use them for maintenance; they will not bind.

When the road surface is so worn as to begin raveling from the loss of fine bonding material, coarse sand or stone screenings should be spread in a thin layer over the surface. The application of the coarse sand may be made along the center line of the road in a small even ridge, and is soon spread by the travel, over the width of the macadam surface. When the coarse screenings which were on the road have been worked to the edges of the road by the traffic, these should be swept back to the center of the road with push brooms.

SUPPLY OF STONE.—A supply of No. 2 stone and screenings should always be distributed along the roadside in neat piles of sufficient size to prevent scattering.

At least 16 tons of stone and 4 tons of screenings, free from dust, should be distributed along each mile of road to be maintained.

By proper maintenance, the life of the road may be doubled, and the heavy cost of frequent resurfacing thereby avoided.

WHO SHALL DO THE WORK.—Undoubtedly the best system for maintenance for the class of work above described is that which provides for a permanent force of skilled laborers or patrolmen, each of whom has a horse and cart, with hand tools, such as pick, shovel, rake and tamper, and carries a barrel of water in his wagon. Each patrolman (in extreme

cases, one or two helpers) should have charge of from 3 to 10 miles of road according to width, traffic and climatic conditions. He should be employed continuously for 8 or 9 months in the year and, in some places, all the year. The cost of this service ranges from $75 to $125 per mile of roadway 15 feet wide, according to price of labor and conditions.

Under some conditions, a combination of the gang and the patrol systems may give the best results. In these cases the patrolmen look after their particular sections of road during certain seasons, say, late spring, summer and early fall, and at other times, late fall and early spring work in small gangs. They can thus do work that requires more than one man's services. The assignment and regulation of the work of the patrolmen, should be left to the engineer in charge of the work.

The Care of the Roadside

There has been a general disposition to regard the care of the roadside as desirable but unimportant, except that proper drainage is generally recognized to be of fundamental importance. The care of the roadside, however, is of greater importance than is generally realized. Shade trees are beneficial and will add to the life of the road surface. Aside, however, from the beneficial effect upon the road itself, the appearance of the roadside and its attractiveness to those traveling upon the highway have been too generally ignored. Scores of millions of dollars have been expended annually in this country on road surfaces, and a slight additional expenditure to make our highways more attractive is certainly justified. Roads are commonly laid out at a width of at least 50 ft., often 66 ft., and frequently 80 feet., while a very narrow strip, usually not more than 18 ft. in the central portion is devoted to travel. It is generally admitted that the shoulders and the side ditches should be kept free from grass and weeds and that the flow of surface water should be unobstructed; but what about the remainder of the space within the side lines of the road? It is usually ragged, unkempt and slovenly. Very little tree planting is done, and were it not for the foresight of preceding generations many of our roads would be entirely destitute of trees. It is true that the space at the side of the road is needed for the storage of material used in maintenance, but that such a use is not inconsistent with a neat and attractive appearance of the roadside is obvious to anyone passing along the highways of Great Britain or Continental Europe. Although the English roads are much narrower than those in America, the hedge

rows and trees which line them are well kept and form charming road pictures. The great national roads of France are almost invariably planted with trees on both sides and as these roads commonly run in straight lines across the country from town to town, these rows of well kept trees are a conspicuous feature of the countryside. Our roads are being improved to attract travel. Why then should not more attention be given to the appearance of the roadside instead of devoting all of the study and the funds to maintaining the surface of the traveled way? This is done in other countries; it is done in certain parts of the United States, especially in Massachusetts, and it should be accepted generally as an important phase of highway improvement and maintenance.

Dust Preventives

Expedients for dust prevention, for roads in the open country, should be considered in relation to each particular road or type of road, and there are involved as important factors:

(a) Probable traffic on the road.
(b) Materials economically available for construction.
(c) Funds and organization available for construction.
(d) Funds and organization available for maintenance.

Assuming the three latter (b), (c), and (d), to have been established, the question is mainly one of adapting dust preventives to various types of road in a manner suitable to traffic over them. We have, therefore, to consider:

1. Materials and methods of dust laying.
2. Types of material available for the road surface.
3. Gradation of traffic.

1. Materials and Methods of Dust Laying

A. These in general consist of purely surface or carpet treatment such as:

(a) Water sprinkling.
(b) Mineral Oils:
  (1). Asphaltic base,
    Heavy for hot application,
    Light for cold application.
  (2). Paraffin base.
(c) Asphalt with naphtha:
    Heavy for hot application,
    Light for cold application.
(d) Tar:
    Heavy for hot application.
    Light for cold application.
(e) Asphaltic Emulsion.
(f) Oil Emulsions.
(g) Calcium chloride.

B. Dustless construction, including:

(a) Bituminous concrete on,
  (1). Concrete foundation,
  (2). Telford, broken stone or gravel foundation.
(b) Bituminous penetration on
  (1). Concrete foundation,
  (2). Telford, broken stone or gravel foundation

(c) Vitrified brick, stone, wood and other block pavements.
(d) Cement concrete,
(Glutrin, Rocmac, or other partially dustless construction.)

2. Types of Surface Material Available

It is commonly desirable to construct roads of the most suitable material available in the locality. These may be considered under:

1. Sand.
2. Gravel.
3. Soft broken stone, such as limestone.
4. Hard broken stone, such as granite or trap.
5. Vitrified brick, stone, wood and other blocks.
6. Concrete.
7. Two or more of the foregoing, permitting selection for foundation and surface.

3. Gradation of Traffic

Standards of traffic intensity have not been officially established by any organization, but are much needed. The following clasification is suggested as including all material variation of traffic:

Horse-drawn Steel tires.	Pleasure vehicles.	Single horse. Double or pair.	
	Farm or Commercial vehicles.	Single	Loaded. Not loaded.
		Double	Loaded. Not loaded.
	Extraordinary.	Quarry, brickyard or other regular and destructive traffic.	
Self-propelled Rubber tires.	Pleasure vehicles.	Less than 7-seat motor. Seven-seat or over.	
	Commercial trucks.	Loaded. Not loaded.	
	Extraordinary	Motor bus or other special traffic.	
Self-propelled Steel tires.	Steam lorries and tractors, with trailers, etc.		

As a simplified classification, for the present purpose, with standards of traffic, the following is suggested:

1. Horse-drawn Steel tires.	A.—Light vehicles.	(1) Light—up to 100. (2) Medium—100 to 200. (3) Heavy—200 up.
	B.—Heavy vehicles, wagons, trucks.	(1) Light—to 75. (2) Medium—75 to 150. (3) Heavy—150 up.
2. Self-propelled Rubber tires.	C.—Passenger automobiles.	(1) Light—up to 100. (2) Medium—100 to 400. (3) Heavy—400 up.
	D.—Motor trucks and buses.	(1) Light—up to 10. (2) Medium—10 to 20. (3) Heavy—20 up.
3. Self-propelled Steel tires.	E.—Steam lorries and tractors.	(1) Light—1. (2) Medium—2 to 6. (3) Heavy—6 up.

In further reference to traffic, the various factors of the foregoing schedule will be described by letter and number thus:

A (3), B (2), C (2) would mean "Light vehicles, heavy traffic—heavy vehicles, medium traffic—passenger automobiles, medium traffic."

Conclusions

(1) Surface material.	(2) Maximum traffic on which it can be considered.	(3) Treatment for dust.	(4) Remarks.
1. Sand.	A1+B1+C1	Asphaltic oil hot application. Calcium Chloride.	A temporary form of improvement, if sand is coarse and other durable material not available.
2. Gravel.	A2+B2+C3+E1	Asphaltic oil cold application.	Should have careful maintenance proportionate to traffic; using the log drag weekly —temporary.
3. Gravel	A2+B2+C3+D1•E1	Bituminous penetration or mix.	Less constant maintenance required and more durable. Life of surface 5 to 10 years with reasonable care.
4. Broken stone, soft, water-bound.	A2+B2+C2+D1+E1	Oil, paraffin base.	Temporary treatment.
5. do	A2+B2+C2+D1+E1	Asphaltic base, cold.	Treatment more lasting.
6. do	A2+B2+C3+D1+E1	Asphalt base, hot.	Treatment more lasting than preceding.
7. do	A2+B2+C3+D1+E1	Tar, cold.	Treatment more lasting than preceding.
8. Broken stone, soft.	A3+B2+C3+D2+E1	Bituminous.	Greater durability requiring annual or biennial carpet coats.
9. Broken stone, hard, water-bound.	A3+B3+C3+D2+E2	Bituminous. concrete or penetration.	Subject to treatments given in 4, 5, 6 and 7, but with greater durability.
10. Concrete	A2+B2+C3+D2	....	Usually dustless in open country requiring occasional sweeping or scraping in places.
11. Vitrified brick stone setts and wood block.	A3+B3+C3+D3+E3	....	

In the foregoing no consideration has been given to character of foundation, which should be recognized as an essential part of the construction for dustless conditions. The foundations required by the several classes of traffic should

be adequate to the loading, and for B3, D and E, special provision must be made.

In the use of carpet coats, a thin film should be sought, rather than a thick covering.

In the case of light oils, care must be taken that sufficient oil is not used to create, after a series of applications, a deeply lubricated surface layer, such as tends to "a wavy condition."

For further consideration:

Relative values of pea gravel, limestone chips, trap and granite chips, sand, etc., for applying to an oiled or tarred surface.

Value of pea gravel, trap or granite chips, as a dust layer.

Etc., etc., etc., etc., etc., etc., etc.

Committee on Standards,
By Nelson P. Lewis, Chairman,

Committee on Standards:

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R. J. Potts
Joseph Hyde Pratt
Frank F. Rogers
George W. Tillson

Report of the Committee on Legislation of the American Road Builders' Association

Introductory.—Highway laws in no two countries or states are alike; all vary one from another in many particulars. This variation has numerous causes but is necessary to meet differences of national or state constitution and municipal organization and local sentiment with respect to roads within the unit of government. In view of area and existing conditions with respect to road control your committee recognizes state legislatures of the United States and the provincial legislatures of Canada as being for the purpose of its report the authorities corresponding to national or central authority in European countries, and submits that any general code of state or provincial laws should embody the following leading principles:

I.

Object of Road Classification.—A classification of roads should be recognized for the following purposes:

(a) To provide for the distribution of cost over the area or population benefited.

(b) To provide for control by the authority representative of the area.

(c) To provide funds for construction and maintenance adequate to the traffic on each of the several classes of road.

II.

Road Classification.—The classification may properly recognize the following divisions:

(a) Main Highways—Consisting of through routes between cities, which because of this fact, or for other reasons, carry much through traffic of motor vehicles from within and without the county, state or province.

(b) Leading market roads, radiating from market centers and shipping points into the rural districts and on which local farm traffic concentrates and predominates.

(c) Local roads, the feeders to the leading market roads or main highways and which serve a limited area.

III.

Distribution of Control.—Each class of road should within reasonable limitation, be under separate authority for construction and maintenance. The most satisfactory plan of organization requires three municipal divisions, state or province, county and town (township), thereby permitting the following division:

(a) Main highways to be administered by the state or provincial authorities.

(b) Leading market roads to be administered by the county authorities.

(c) Local roads to be administered by the township (town) authorities.

IV.

Limitation of State or Provincial Control and Aid.—A central government (state or provincial) should not do for the people what the latter can, by municipal self-government, do for themselves; and state or provincial governments should assume control of roads only for the purpose of securing a proper distribution of the cost, and to carry on work of considerable magnitude, beyond the usual ability of municipal organization to perform.

(State or provincial control of the construction and maintenance of leading market roads may be desirable in those states and provinces where the sentiment for and knowledge of proper methods of road construction is not so advanced that the people of the counties will of themselves demand and provide for proper methods of construction and maintenance.)

V.

Special Financial Provision for Main Roads.—Funds, adequate to the work, should be provided by special taxes, or from bond issue or other capital resources, for the durable construction of main highways and leading market roads. To this end, provincial and state governments may properly subsidize the construction of market roads built under county authority and under state or provincial supervision.

VI.

Bond Issues.—Bonds, issued for road improvement, should not extend beyond the life of the work, based on an estimate of the durability of the several portions—earth work, foundation, surface, and bridges and culverts; adequate maintenance to be assured for such period.

VII.

Maintenance.—Adequate means for raising funds by annual levy for maintenance should accompany all provisions for first construction. Responsibility for maintenance should be vested in the unity of government responsible for construction.

VIII.

Experienced Staff.—Road construction and maintenance is a continuous work, to which a continuous policy and system should be applied. Therefore, elective and political responsibility (which is removable) should be separated from executive responsibility (which should be permanent). Each central authority, county and town (township) corporation should have an executive officer permanently in charge of road construction and maintenance. Experienced engineers, foremen and workmen are necessary for efficient and economical road construction and maintenance, and permanent employment should therefore be guaranteed.

IX.

Centralized Control.—Control of staff should be centralized in the chief executive officer or engineer, who should have full power to direct, employ and dismiss. Appointments made, from the highest to the lowest officer or employee, should be on a basis of merit, and dismissal should be for incompetency only.

X.

Urban Construction.—Urban municipalities should, through state or provincial and county taxation, or other means, contribute to the cost of leading market and main highways.

XI.

Revenue from Motor Vehicles.—Revenue from motor vehicles should constitute a fund, to be administered by the state or province for the maintenance of main roads; and should not be capitalized for construction unless maintenance is otherwise fully provided for.

XII.

Educational and Supervising Authority.—The maintenance of a central office for consulting service and for collecting and distributing information respecting roads and pavements, the testing of materials, and in suitable degree regulating methods of construction and maintenance of all classes of roads to obtain efficiency and uniformity, is a function of state or provincial government. Competent engineering supervision should be provided, as far as may be necessary, by the state or province to enable the central office to know that large township and county expenditures under bond issue are made wisely and economically.

XIII.

Labor Tax.—The labor tax (statute labor) for road purposes is not satisfactory, produces inequality in taxation due to non-collection and favoritism, retards the efficiency of all other expenditure and should be abolished.

XIV.

Traffic Regulation.—Uniform traffic regulations respecting speed of vehicles, width and character of tires, maximum loads, and all rules incidental to the use of the public highways should be prescribed by the state and provincial governments for each state or province, and should not be relegated to local jurisdiction. Uniformity as between states and provinces should be sought as far as practicable.

COMMITTEE ON LEGISLATION,
(Signed) W. A. McLean, Chairman,
A. R. Hirst,
A. N. Johnson,
E. L. Powers,
Joseph Hyde Pratt.

CONSTITUTION

ARTICLE I.
Name.

This Association shall be known as the American Road Builders' Association.

ARTICLE II.
Seal.

The official seal shall be circular in form and bear the words "American Road Builders' Association Corporate Seal 1910."

ARTICLE III.
Location.

The headquarters of the Association shall be located in the City of New York, New York.

ARTICLE IV.
Objects.

The objects for which this Association is organized are to acquire and disseminate information concerning highway construction and maintenance in the States and Cities of the Union and in the Provinces and Cities of Canada; to stimulate interest in the subject and to promote educational, legislative and other measures tending to their accomplishment.

ARTICLE V.
Membership.

Section 1. The Association shall have five (5) classes of members, viz., active, associate, honorary, contributing and life members.

Sec. 2. Active members shall be persons who are actively engaged in laying out or supervising work of construction and maintenance of highways and streets and those interested in highway development. Active members shall be elected in accordance with the by-laws adopted by the Association.

Sec. 3. Associate members shall consist of societies or other organizations interested in the objects of the Association.

Sec. 4. Honorary members shall be those who have performed distinguished service in the cause of highway extension and improvement. They shall be nominated by the Board of Directors and elected by the Association.

Sec. 5. Contributing members shall be commercial bodies who contribute one hundred dollars ($100.00) per year.

Sec. 6. Life members shall consist of active or associate members making a payment of five hundred dollars ($500.00) upon their election to membership.

Sec. 7. Only active members shall vote or hold office.

ARTICLE VI.
Officers.

Section 1. The officers of this Association shall be selected from its active membership and shall consist of a president, three vice-presidents, a secretary, a treasurer and eighteen directors, who, together with the last five living past presidents, shall constitute a board of directors, from which shall be elected an executive committee of three, one of whom shall be the secretary of the Association.

Sec. 2. The President, Vice-President, Secretary and Treasurer shall be elected for one year. Six Directors shall be elected each year to serve for three years, except that at the first annual meeting after the adoption of this Constitution

six directors shall be elected for three years, six for two years and six for one year.

ARTICLE VII.

Sections.

For the purpose of carrying on the work of the Association, sections may be established in as many of the States of the Union and Provinces of Canada as may seem desirable. Each section shall be presided over by an active member of the Association.

ARTICLE VIII.

By-Laws.

By-Laws for governing this Association shall be made by the Board of Directors, subject to the approval of the active membership of this Association.

ARTICLE IX.

Amendments.

Section 1. An amendment of this constitution shall first be proposed by at least five (5) active members and submitted to the Board of Directors, a majority of which shall approve before the amendment, with letter ballot, is sent to the active members of the Association.

Sec. 2. Amendments may be adopted only at any regular or special meeting of the Association, provided that a notice of such meeting, including the proposed amendment and a letter ballot shall have been sent to each member of the Association thirty (30) days before said meeting. An affirmative vote of three-fourths of all ballots cast shall be necessary for the adoption of any amendment.

BY-LAWS

CHAPTER I.

Meetings.

Section 1. The annual meeting of the Association for the election of officers and the transaction of business shall be held on the first Friday in February of each year. Conventions of the Association for the reading and discussion of papers, social intercourse and reports of committees, shall be held at such times and places as the Executive Committee may determine, subject to the approval of the Board of Directors.

Sec. 2. Special meetings may be called by the Board of Directors or may be called on the request of thirty (30) active members, which request shall state the object of the meeting. Notices of such meeting shall be sent out ten (10) days in advance and no other business be considered than that stated in the notice.

CHAPTER II.

Election of Officers.

Election of officers shall be as follows: At the Fall convention a nominating committee of seven (7), not more than two (2) of whom shall be residents of a single state, shall be chosen by the Association, and this committee shall subimt to the Secretary within three (3) weeks the names of not less

than one (1) or more than three (3) candidates for each office to be filled. Letter ballots shall be then sent by the Secretary to each active member at least thirty (30) days before the date of the annual meeting stating the hour at which the polls will close. The ballots shall be returned to the Secretary enclosed in two envelopes the inner one to be blank and the outer one endorsed with the signature of the active member voting. Two tellers shall be appointed by the President, and the result of the ballots shall be announced at the annual meeting. The candidate having the largest number of legal votes by letter ballot shall be declared elected.

In case of failure to elect an officer on account of a tie vote, the meeting shall proceed to ballot for such office, the choice of candidates being limited to the persons so tied. Vacancies occurring in any office may be filled by the Board of Directors at any meeting provided notice of such vacancy shall be sent to each member of the Board at least ten (10) days before such meeting. A majority of the votes cast shall be necessary to elect.

CHAPTER III.

Duties of Officers.

Section 1. The President shall be the presiding officer at all meetings of the Association, and shall perform the duties usually devolving upon such officer. The President shall be ineligible for re-election for one year.

Sec. 2. The First Vice-President shall, in the absence of the President, preside at the meetings of the Association, and in the disability of the President shall perform the duties of the President.

Sec. 3. The Second Vice-President shall, in the absence of the President and First Vice-President, preside at the meetings of the Association and perform the duties of the President.

Sec. 4. The Third Vice-President shall, in the absence of the President and First and Second Vice-Presidents, preside at the meetings of the Association and perform the duties of the President.

Sec. 5. The Secretary shall keep the records and complete reports of the proceedings of the Association, and shall conduct all necessary correspondence connected with the affairs of the Association. He shall notify all members who are in arrears in dues and shall attend to such other affairs of the Association as fall particularly to his office, and such other duties as may be placed upon him by the Board of Directors. At the annual meeting of the Association, the Secretary shall make a written report of the work, and shall also make such special reports to the Board of Directors as it may require from time to time. He shall draw all vouchers on the Treasurer for the payment of money.

Sec. 6. The Treasurer shall hold in safe keeping, in a bank designated by the Board of Directors, all the moneys paid to the Association, and shall expend same only in the payment of vouchers duly drawn by the Secretary and approved by the President or such general officer as may be designated by him. He shall keep an accurate account of receipts and expenditures, and shall make a written annual report at the

annual meeting of the Association. He shall submit his annual report to the Board of Directors on or before the second Friday in January. If required by the Board of Directors, the Treasurer shall file a bond in such amount as may be required.

Sec. 7. The Board of Directors shall have the general management of the affairs of the Association as trustees, in conformity to the laws under which the Association is organized and the provisions of the constitution. It shall direct the investment and care of the funds of the Association, make appropriations for specific purposes and take measures to advance the interests of the Association. The Board of Directors shall make an annual report at the annual meeting, and shall transmit the report of the Secretary and Treasurer and other officers and committees. These reports shall be printed and sent to the members of the Association at least ten (10) days before the annual meeting.

Sec. 8. The Executive Committee shall exercise a general supervision over the affairs of the Association. It shall report annually to the Board of Directors the condition of the Association and recommend any measures which seem advisable to adopt for the best interests of the Association. The Executive Committee shall also have such other powers as may be given it from time to time by the Board of Directors.

CHAPTER IV.

Election of Members.

Applications for membership shall be made on forms provided by the Association and endorsed by one active member and shall be acted upon by the Executive Committee. Upon the approval of the Executive Committee and payment of the required dues, the applicant shall become a member.

CHAPTER V.

Dues.

Section 1. The annual dues for active members of the Association shall be three dollars ($3.00), payable in advance.

Sec. 2. The annual dues for associate members shall be ten dollars ($10.00), payable in advance.

Sec. 3. Annual dues for contributing members shall be one hundred dollars ($100.00), payable in advance.

Sec. 4. Dues shall be due and payable January 1st of each year.

Sec. 5. Neglect to pay dues for six months after notification by the Secretary shall be sufficient cause for the removal of the member's name from the roll by the Executive Committee without further notice.

CHAPTER VI.

Quorum.

Section 1. Five directors shall constitute a quorum at any regular or special meeting of the Board of Directors.

Sec. 2. Fifteen active members shall constitute a quorum at any regular or special meeting of the Association.

CHAPTER VII.

Congresses.

If it shall be deemed expedient to hold a congress of road builders in connection with any of its conventions, no action

that such congress may take shall be binding upon the American Road Builders' Association, except the Association shall vote to be so bound.

CHAPTER VIII.

Amendments to By-Laws.

These by-laws may be amended, revised or changed by the Board of Directors, subject to the approval of the voting membership at its next regular meeting. Emergency changes may be made temporarily effective by the consent of the majority of all the members of the Board, but such changes shall only be effective until the next meeting of the Association, when it shall be voted upon by the Association.

OFFICERS, 1915

President

GEORGE W. TILLSON, M. Am. Soc. C. E.

Consulting Engineer to the President of the Borough of Brooklyn, New York City.

First Vice-President

A. W. DEAN, M. Am. Soc. C. E.

Chief Engineer, Massachusetts Highway Commission.

Second Vice-President

AUSTIN B. FLETCHER, M. Am. Soc. C. E.

State Highway Engineer of California.

Third Vice-President

*S. PERCY HOOKER

State Superintendent of Highways of New Hampshire.

Secretary

E. L. POWERS,

Editor "Good Roads."

Treasurer

W. W. CROSBY, M. Am. Soc. C. E.

Consulting Engineer.

PAST PRESIDENTS

(Members of the Board)

JAMES H. MACDONALD

Ex-State Highway Commissioner of Connecticut.

HAROLD PARKER, M. Am. Soc. C. E.

Ex-Chairman, Massachusetts Highway Commission.

NELSON P. LEWIS, M. Am. Soc. C. E.

Chief Engineer, Board of Estimate and Apportionment of New York City.

SAMUEL HILL

President, Washington State Good Roads Association.

W. A. McLEAN, M. Can. Soc. C. E.

Chief Engineer of Highways and Commissioner, Ontario Public Roads and Highways Commission.

DIRECTORS

TERM EXPIRES 1918

E. A. FISHER
Chief Engineer of Rochester, N. Y.

A. R. HIRST
State Highway Engineer of Wisconsin.

JOSEPH W. HUNTER
First Deputy Commissioner, Pennsylvania State Highway Department.

FRANK F. ROGERS
State Highway Commissioner of Michigan.

WILLIAM R. SMITH
General Manager, Lane Construction Corporation.

H. M. WAITE
City Manager of Dayton, O.

TERM EXPIRES 1917

T. R. AGG
Professor of Highway Engineering, Iowa State College.

W. E. ATKINSON
State Highway Engineer of Louisiana.

ARTHUR H. BLANCHARD, M. Am. Soc. C. E.
Professor of Highway Engineering, Columbia University.

FRED. E. ELLIS
Manager, Essex Trap Rock & Construction Co.

R. H. GILLESPIE, M. Am. Soc. C. E.
Chief Engineer of Sewers and Highways, Borough of the Bronx, New York City.

PAUL D. SARGENT, M. Am. Soc. C. E.
Chief Engineer, State Highway Commission of Maine.

TERM EXPIRES 1916

WM. H. CONNELL, Assoc. M. Am. Soc. C. E.
Chief, Bureau of Highways and Street Cleaning of Philadelphia, Pa.

T. COLEMAN DU PONT
Pres., E. I. du Pont de Nemours Powder Co.

C. A. KENYON
President, Indiana Good Roads Association.

WALTER G. LEININGER
Superintendent of Streets of Chicago, Ill.

R. A. MEEKER
State Highway Engineer of New Jersey.

LOGAN WALLER PAGE, M. Am. Soc. C. E.
Director, U. S. Office of Public Roads.

EXECUTIVE COMMITTEE

A. W. DEAN
NELSON P. LEWIS
E. L. POWERS

COMMITTEE ON LEGISLATION

W. A. McLEAN, Chairman
A. R. HIRST
A. N. JOHNSON
E. L. POWERS
JOSEPH HYDE PRATT

COMMITTEE ON STANDARDS

NELSON P. LEWIS, Chairman
HENRY L. BOWLBY
A. W. DEAN
A. B. FLETCHER
S. D. FOSTER
C. A. KENYON
W. A. McLEAN
R. J. POTTS
JOSEPH HYDE PRATT
FRANK F. ROGERS
GEORGE W. TILLSON

*Died March 24, 1915.

LIST OF ACTIVE MEMBERS

ACTIVE

ABBOTT, D. K., Genl. Sales Agent, Austin Western Road Machinery Co., 910 S. Michigan Ave., Chicago, Ill.
ABBOTT, H. C., Engr., Lehigh Portland Cement Co., Consumers Bldg., Chicago, Ill.
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AFFLECK, B. F., Pres., Universal Portland Cement Co., 208 S. La Salle St., Chicago, Ill.
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ALLEN, LUCIUS E., Cons. Engr., Hastings County, Belleville, Ont., Canada.
ALLMAN, THOS. H., County Engr., Wahkiakum County, Cathlamet, Wash.
AMBLER, JOHN NICHOLAS, Cons. Engr., 661 W. 5th St., Winston-Salem, N. C.
AMUNDSON, L., County Highway Commissioner Wood County, Plover St., Grand Rapids, Wis.
ANDERSON, JAMES, Road and Gnl. Contractor, Menands, N. Y.
ANGELL, CHAS. A., Vice-Pres., Cranford Co., 190 Montague St., Brooklyn, N. Y.
ANNIS, ROSS E., Salesman, The Texas Co., 18 Oakland St., Natick, Mass.
ANSCHUTZ, H. E., Highway Engr., De Soto County, Arcadia, Fla.
ARNOLD, C. H., Chief Clerk, Road Dept., Allegheny County, Court House, Pittsburgh, Pa.
ASHER, JOE, County Judge, Little Rock, Ark.
ASHLEY, C. A., City Engr., Naperville, Ill.
ATKINSON, T. R. Bismarck, N. D.
ATKINSON, W. E., State Highway Engr., New Orleans Court Bldg., New Orleans, La.
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BALL, JAMES W., Contractor, Wyncote, Pa.
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BANKS, GEO. N., Contractor, Wildwood, N. J.
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BARBER, WILLIAM, Supt. of Construction, 106 Romesvallos Ave., Toronto, Ont., Canada.
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BASHFORD, LESTER J., County Supt. of Highways, Columbia County, Hollowville, N. Y.
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BEACH, R. C., Pres., State League of Commercial Bodies of Idaho, Lewiston, Idaho.
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BECK, HARRY N., City Manager, Grand Haven, Mich.
BECK, RAYMOND, Chief, Touring Bureau, B. F. Goodrich Co., Akron, O.
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BECKLEY, A. J., Mgr., Beckley Perf. Co., North Ave., Garwood, N. J.
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BENNETT, MARCH G., Genl. Mgr., Samuel Cabot, Inc., 141 Milk St., Boston, Mass.
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BLANEY, CHARLES D., Chmn., Cal. State Highway Commission, Saratoga, Cal.
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BOOMER, PERLEY E., Civil Engr., Maxine Park Land Co., Landing P. O., N. J.
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BOWER, CHARLES E., County Supt. of Highways, Steuben Co., 163 E. 2nd St., Corning, N. Y.
BOWLBY, HENRY L., former State Highway Engineer of Oregon, Salem, Ore.
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BRADT, S. E., Secy., Ill. State Highway Commission, De Kalb, Ill.

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CAMPBELL, M. M., Engr. and Surv., Road Dept., Corp. of Montreal, P. O. Box 385, Montreal, P. Q., Canada.
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CHAMBERLAIN, ARTHUR B., Chicago, Ill.
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